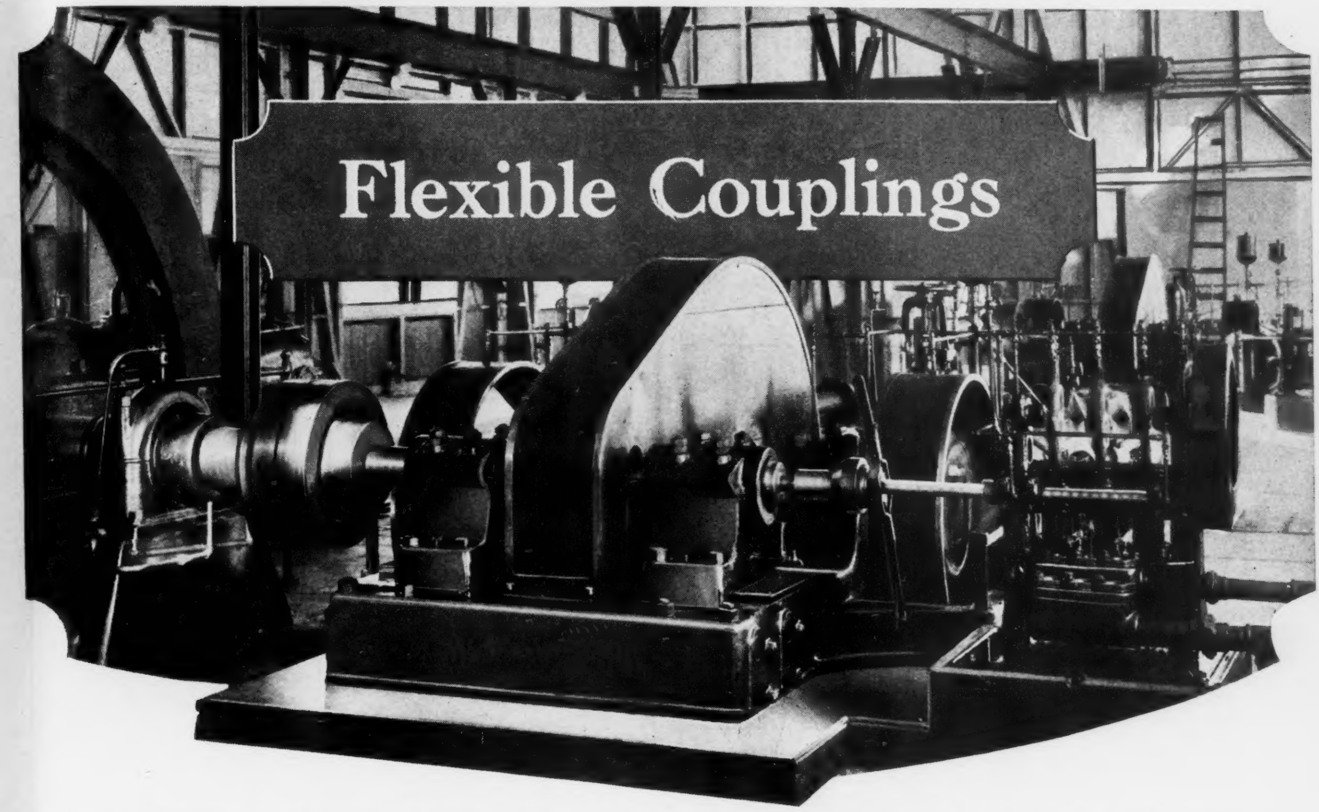
MARCH, 1925 VOL. 31 NO. 7

MACHINERY

THE INDUSTRIAL PRESS Publishers, 140-148 LAFAYETTE ST., NEW YORK



Flexible Couplings

A Review of Various Commercial Types, Their Characteristics and General Applications

By CHARLES H. CLARK

THERE is no real substitute for reasonably good shaft alignment. No mechanical device has yet been perfected that will allow the designing engineer to forget that it is one of his duties to design foundations, bed-plates, and bearings, so that the shafts can be well lined up at the start and, under normal operating conditions, will stay in reasonably good alignment. Nor can the erecting engineer merely throw the machines together, without due regard to shaft alignment, and then expect to obtain satisfactory operation. The operating engineer must often start where the designing and erecting engineer left off; it is usually one of his duties to check the alignment of all shafting when new machines are given into his care. Frequently the lowest operating costs are found in plants where a recheck of shaft alignment is made at least once or twice each year.

On slow-speed lineshaft drives, where the shaft is supported in bearings 8 to 10 feet apart, it is often permissible to operate with as much as 0.010 inch misalignment per foot of shaft length, in spite of a rigid coupling, because the shaft itself is somewhat flexible. Even on lineshaft drives, however, the shafts should be lined up, and they should be kept in alignment within reasonable limits; otherwise there will result excessive frictional losses in bearings, hot bearings, scored shafts, or perhaps a broken shaft or coupling. The shafts of direct-connected machines, such as motors, turbines, engines, pumps, fans, and innumerable others, are relatively much larger and stiffer than lineshafts, for the reason that these shafts are designed to support heavy machine parts and to operate at relatively high speeds and with bearings spaced relatively close together. So they are made stiffer to carry the heavy bending strains imposed upon them.

This review of various commercial types of flexible couplings covers their characteristics and general application, and includes illustrations of twenty-seven different designs. The table on page 510 in which the general characteristics of various types of flexible couplings are given in condensed form, represents a compilation that required much time and research, and applies to flexible couplings designed primarily for general use. The author of this article is an expert on the subject of flexible couplings, and he has dealt with the subject from an unbiased viewpoint. The article explains tersely the outstanding constructional features, the operating characteristics, and the conditions under which various forms of flexible couplings may be employed to advantage.

Function of Flexible Couplings

Since it is practically impossible to design, build, and maintain direct-connected machines so that their shafts will stay in perfect alignment, a rigid connecting of such units almost invariably results in trouble. Flexible couplings have been developed primarily to meet this problem, so as to prevent, as far as possible, excessive friction losses in bearings, overheating of bearings, scoring of shafts, and breakage of shafts and couplings. While they are widely used for various other needs, such as for motor boats, automobiles, and fractional horsepower units (including magnetos), we will consider in this article only those kinds of flexible couplings that are suitable for general machinery use, in sizes ranging from a 1-inch shaft diameter, up to the largest shaft size.

The nature and amount of flexibility a coupling provides does not alone determine its fitness for general use. The cost of manufacturing the device, its durability and length of life, the cost of making repairs, the ease

with which it may be lined up, and many other factors should often be considered before making a final choice. But coupling flexibility is of prime importance, for we always find some misalignment present; in practice no two shafts can ever be exactly parallel, and they are always out of center as well. A flexible coupling should take care of these conditions within reasonable limits, should allow end play in the connected shafts, and should not change their angular velocity at any point in the revolution. By "flexibility" in a coupling, we mean any yield or "give," in the form of mechanical motion or distortion of the elastic material of the coupling, which is produced by a force acting in a specified direction—namely, angular, radial, axial, or tangential.

Angular, Radial, Axial, and Tangential Flexibility

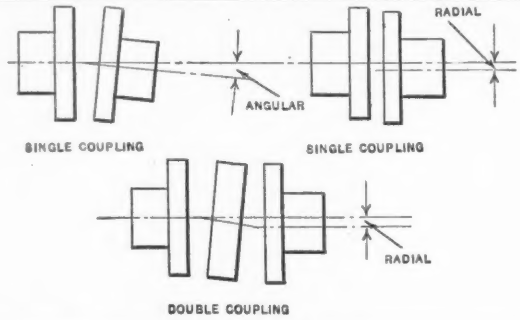
Shafts that are not parallel have an *angular misalignment*, the amount of which is expressed in degrees or else in fractions of an inch per foot of shaft length. A coupling that permits angular misalignment in connected shafts is said to have *angular flexibility*, but probably not more than one per cent of the couplings used for general machinery purposes are required to connect shafts that are intentionally misaligned. Nearly all the couplings listed in the accompanying table will easily permit the usual misalignment. A slight angular misalignment is the least difficult condition for most flexible couplings to meet, since it calls for the simplest form of flexibility.

Shafts that are out of center have a *radial misalignment*, the amount of which is the radial distance separating the center line of one of the connected shafts from the center line of the other at a point midway between their two ends. A coupling permitting radial misalignment is said to have *radial flexibility;* but when we speak of radial flexibility of a coupling, we assume that the shafts are approximately parallel, for only under such conditions will the coupling permit the maximum amount of misalignment.

A coupling that permits an independent endwise floating movement of the connected shafts is said to have *axial flexibility*. Motor shafts especially require couplings of this type, for the electric center of the motor varies with the load. Simply building a coupling to permit axial flexibility under light loads is no guarantee that the shafts will have a free and independent endwise float under a heavy load, for the friction surfaces in the coupling may be overloaded or not properly lubricated, and, moreover, the transmission elements may cause an end thrust when distorted by a torsional load. Disk couplings tend to resist axial flexibility under no load, but will permit axial flexibility when subjected to torsional stress.

CHARACTERISTICS OF FLEXIBLE SHAFT COUPLINGS FOR GENERAL APPLICATION

Shaft couplings may be divided into the rigid type, the clutch type, and the flexible type. Flexible designs may be intended for general application or primarily for special use, as in automotive transmissions; magneto driving; motor boats; and fractional horsepower installations. This table covers designs adapted for general use.



Type	No.	General Constructional Features	Do hubs disengage?	Are there any wearing surfaces?	Are wearing surfaces lubricated?	Is a grease-tight housing furnished?	Are four bearings needed?	Is there any backlash?	Are shocks cushioned?
Single Coupling	1	Double-slider crank (Oldham)	no	yes	*	*	yes	no	no
	2	Double-slider disk (Higgins)	no	yes	yes	no	yes	no	no
	3	Internal toothed hub, radial springs with clearance (Brown)	yes	yes	yes	yes	*	yes	yes
	4	Internal toothed hub, radial springs with keepers (Francke)	yes	yes	yes	yes	*	no	yes
	5	Male and female toothed hubs, helical springs (Meriam)	yes	yes	yes	yes	yes	yes	yes
	6	Perforated flanges, interlocking leather disk (Grundy)	*	yes	no	no	yes	*	yes
	7	Perforated flanges, axially aligned laminated springs (Francke)	yes	yes	yes	yes	*	no	yes
	8	Pins, fiber-bushed hubs	*	yes	no	no	*	*	no
	9	Pins, leather-bushed hubs	*	yes	no	no	*	*	yes
	10	Pins, rubber-bushed hubs	*	yes	no	no	*	no	yes
	11	Pins, fiber disk (Jones and others)	*	yes	no	no	*	*	no
	12	Pins, leather disk (Jones and others)	*	yes	no	no	*	*	yes
	13	Pins, rope or leather connections (Jones and others)	*	yes	no	no	yes	*	yes
	14	Steel disk, four-point drive (Clark)	yes	no	...	no	no	no	yes
	15	Steel disk, six-point drive (Thomas)	yes	no	...	no	no	no	yes
	16	Sprockets, loosely mounted chain (Clark)	yes	yes	yes	yes	*	yes	no
	17	Sprockets, loosely mounted chain, chain springs (Clark)	yes	yes	yes	yes	*	no	yes
	18	Sprockets, snugly mounted chain (Clark)	yes	yes	yes	yes	no	no	no
	19	Spiders, helical springs (Nuttall)	*	*	*	*	*	no	yes
	20	Spiders, rubber cylinders	*	*	no	no	yes	no	yes
	21	Toothed hubs, spring grid, housing (Falk, Bibby)	yes	yes	yes	yes	*	*	yes
	22	Universal joint (for straight-line drives) (Mesta)	*	yes	yes	no	no	no	no
Double Coupling	23	Double universal joint (for straight-line drives) (Mesta)	*	yes	yes	no	yes	no	no
	24	Floating double sprocket, two chains (Clark)	yes	yes	yes	yes	yes	no	*
	25	Floating member, axially aligned laminated springs (Francke)	yes	yes	yes	yes	yes	no	yes
	26	Floating member, four-point drive disk (Clark)	yes	no	...	no	yes	no	yes
	27	Floating member, six-point drive disk (Thomas)	yes	no	...	no	yes	no	yes
	28	Toothed hubs, floating meshing internal gear (Fast)	yes	yes	yes	yes	yes	no	no
	29	Floating housing, triangle faced hubs (Clark)	yes	yes	yes	yes	no	no	yes
	30	Floating triangle faced member, two housings (Clark)	yes	yes	yes	yes	yes	no	yes

Machinery

*Depends upon installation.

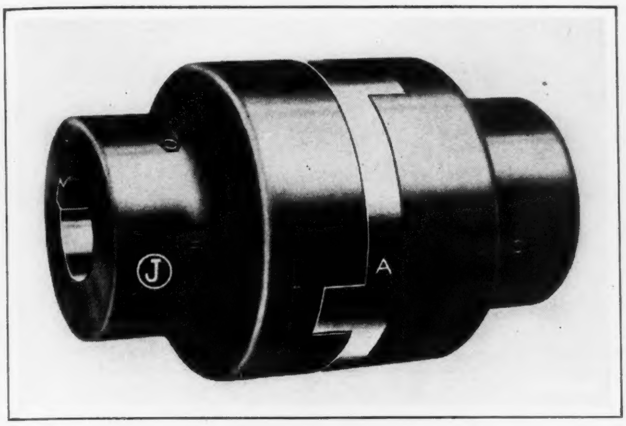


Fig. 1. Double-slider Crank or Oldham Type of Coupling

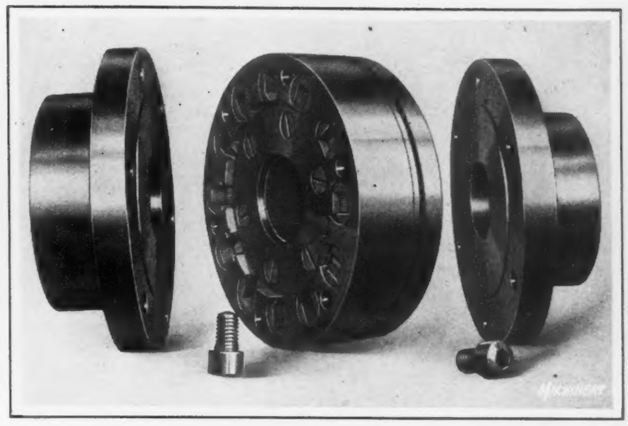


Fig. 2. Coupling having Laminated Radial Springs and Keepers

Couplings that possess a certain amount of torsional resiliency are said to have *tangential flexibility*. This result, whether intentional or incidental, is due to an elastic transmission element in the coupling such as leather, rubber, or springs. It must not be confused with backlash, which is caused by clearance between the load-carrying surfaces and in some cases by the structure of the coupling itself. Backlash is by no means a desirable feature, since it represents the amount that one coupling hub must rotate before any resilient member is subjected to torsional stress. Couplings with a tendency toward backlash are suitable only for constant direction drives. Tangential flexibility tends to cushion backlash, but certainly the best all-around couplings have the very least amount of backlash.

Some of the best types of couplings possess little or no tangential flexibility. Occasionally, however, a coupling is required to cushion sudden shocks and thereby keep the stresses within safe bounds, as otherwise, the flywheel effect of the driving unit might intensify the stresses to the rupture point in the driven machine. A resilient connector will act as an accumulator to absorb temporarily a limited amount of the excess energy. A shock-absorbing coupling may also be used in reversing service, provided it is strong enough to resist the force of the driving unit, plus the accumulated energy of the driving unit obtained through tangential flexibility. A resilient connector will also serve to dampen out vibrations and prevent them from damaging the motor windings, the surface of gear teeth, and other machine parts that are not intended to resist these destructive vibrations.

Springs used in couplings should be designed so as to prevent the establishing of a resonance between the vibrations of the spring and the periodic torsional impulses of the connected units; otherwise, the spring may become overstressed. Springs that have a rising characteristic will prevent synchronous vibrations, for they will have a different frequency of vibration for each increment of deflection. The friction between the laminae of laminated springs gives a slight rising characteristic, but this friction is often reduced by the lubrication needed to increase the life of the spring.

Single and Double Couplings

Couplings vary greatly in structure and in the nature of their flexibility. Some drive directly from one hub to another, while others possess one or more floating transmission elements, which compensate for both angular and radial misalignment. Flexible couplings may be classified in a number of ways according to their structure, but the most important difference in design has to do with the manner in which the floating transmission element permits flexibility; if it functions like a dummy shaft, the coupling is classed as a double coupling; otherwise, it is classed as a single coupling.

Double couplings may consist of two single couplings connected by a dummy shaft, or else two or more couplings built into one compact unit. Not all single couplings, however, are adapted for this purpose, only those being used that naturally tend to center connected shafts, or that may be especially constructed to do so. Such a coupling will center the floating element so that its center line will intercept the center line of each connected shaft at the transverse center line of the load-carrying surface or body in flexure; thus angular misalignment only is present at these points when the connected shafts are radially misaligned. It is seen, then, that while a double coupling as a whole permits radial flexibility, its own floating shaft, or floating transmission element, is subjected to angular misalignment only.

General Requirements for Flexible Couplings

Shaft bearing thrusts (radial thrusts), in general, are not a serious factor to contend with when flexible couplings are used, but in some cases considerable flexibility must be provided if shaft thrusts are to be avoided. Shaft thrusts are affected by angular misalignment, but the thrust is least when the center line of the shafts intercept at the transverse center line of the coupling's load-carrying surfaces or body in flexure. On regulation straight-line drives, however, this condition is usually of little importance.

Most flexible couplings under misaligned conditions must withstand a certain amount of friction, and friction means wear. On this account some method of lubrication is desir-

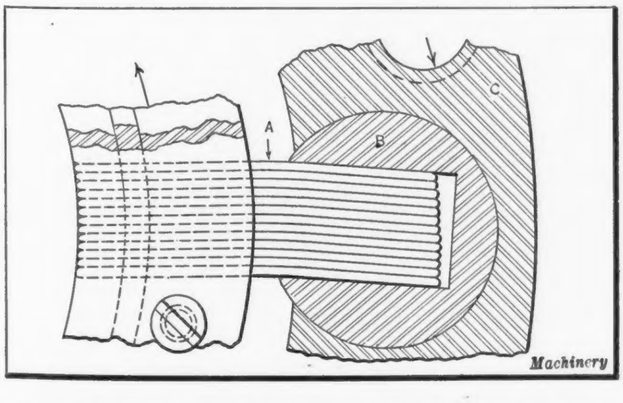


Fig. 3. Spring and Keeper Construction of Coupling shown in Fig. 2

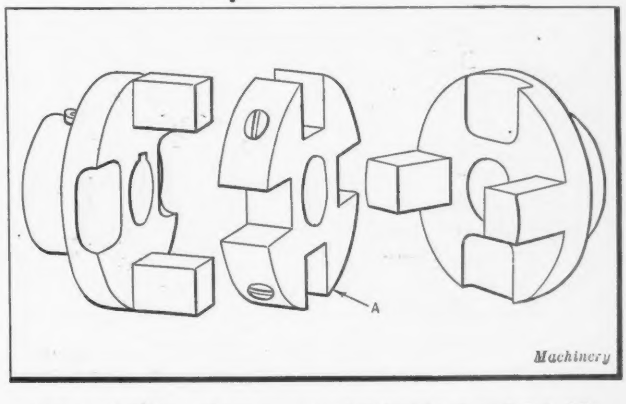


Fig. 4. Coupling designed on the "Double-slider Crank" Principle

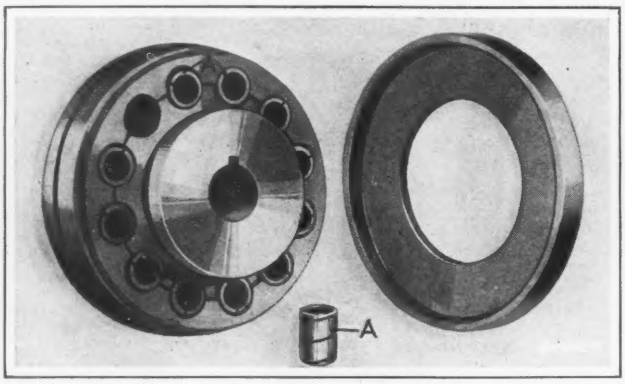


Fig. 5. Coupling having Helical Springs mounted in Circular Recess between Internal and External Hubs

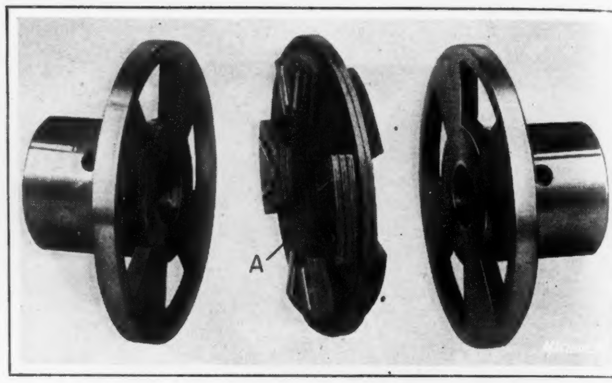


Fig. 6. Coupling provided with Perforated Flanges which interlock with a Leather Disk

able. When rubber is used, it cannot be lubricated, but its life can be increased through the use of metal ferrules to line it. Leather such as "Tannite" contains ample lubrication to resist wear, and will last many years under compression; it also resists heat, chemicals, and the oil used to lubricate metal parts of the coupling. Perishable material used in a coupling should be renewable, as well as all overloaded metal wearing parts, even though thoroughly lubricated. A coupling should be so designed that it will serve at all times as an indicator of shaft alignment, for close alignment reduces coupling wear. Nearly all large couplings and many small ones must be designed to come apart without an axial shift of either shaft, which often would be difficult and sometimes even impossible to make; moreover a disengagement of the hubs should be made possible so that both hubs can be rotated independently.

For high-speed drives, all couplings should be carefully balanced; otherwise, they will vibrate and be noisy. Noise may also be caused by backlash in a coupling that is not provided with cushioning means. Sometimes an improper selection of a coupling to suit conditions will cause noise, such as, for example, the failure to select a shaft-centering coupling to support the free end of a shaft.

Any specification as to operating limits for the several types of commercial flexible couplings described is practically impossible, for they are all subject to modifications of design to meet unusual operating conditions. It is a safe rule to use greater care as to alignment of shafts for high speeds than for low speeds. Most turbine builders line up their machines initially within 0.002 to 0.004 inch. On lower speeds and usual duty, 0.010 inch is good practice and easily obtainable without micrometer gages. However, on especially heavy duty with continuous process drives, where machines cannot be stopped except after long periods of operation to check and correct alignment, or where nonrigid foundations are used, it is generally advisable to use a double type coupling.

Double-slider Crank (Oldham)—Double-slider Disk

The double-slider crank or Oldham coupling has a floating member *A*, Fig. 1, which interlocks with each hub face and permits a radial sliding movement; the movement in one hub face is at right angles to the movement in the other hub face. Flexibility is thus permitted in every way except tangentially. When shafts are radially misaligned, the center of the floating member makes two complete circles during each revolution of the shafts, the diameter of the circle equaling the radial misalignment of the shafts. For this reason, the coupling should be accurately aligned at high speeds; otherwise, the floating member will set up a vibration. Couplings of this type are usually difficult to lubricate, but unless they are lubricated, backlash will soon develop. This coupling is strong and will give good service if properly cared for. A summary of the characteristics of this coupling and of all the other types dealt with in this article, is given in the accompanying table. For convenience, the various designs have been given numbers. For the double-slider crank coupling, see No. 1.

The double-slider disk type consists of three main members which are shown separated in Fig. 4. This coupling works on the "double-slider crank" principle, but its floating member *A* consists of a slotted disk mounted between the hub faces, each of which has a pair of projecting lugs which interlock at right angles to the pair on the opposite hub. Alignment is thus freely compensated for in every direction. The coupling also permits axial flexibility, but no tangential flexibility. The center of the disk rotates in a circle, twice to each revolution of the shaft when the shafts are radially misaligned; but the disk is light, being made of fibrous material, and therefore is not so likely to cause vibration under this condition as though it were made of metal. The fibrous material also permits a seepage of oil through its pores from a central reservoir to the bearing surfaces of the slots. (See coupling No. 2 in the table).

Couplings Having Toothed Hubs and Springs

The coupling shown in Fig. 7 has an internal notched hub and radial springs with clearance. The inner ends of these radial laminated springs *A* are firmly fixed to one hub *B*, while the free outer end engages the teeth of an oil-tight internal toothed member *C* attached to the other hub *D*. A slight amount of clearance is permitted between each

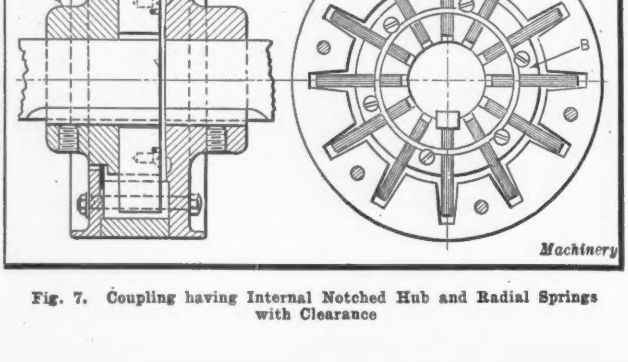


Fig. 7. Coupling having Internal Notched Hub and Radial Springs with Clearance

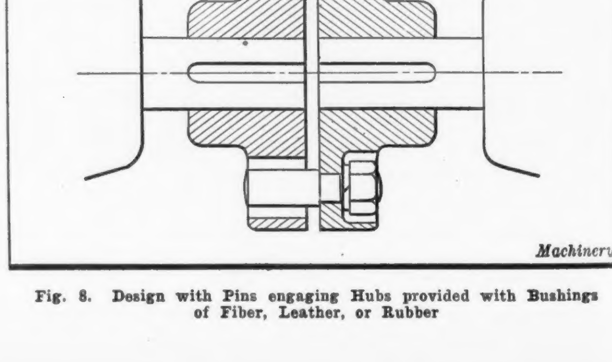


Fig. 8. Design with Pins engaging Hubs provided with Bushings of Fiber, Leather, or Rubber

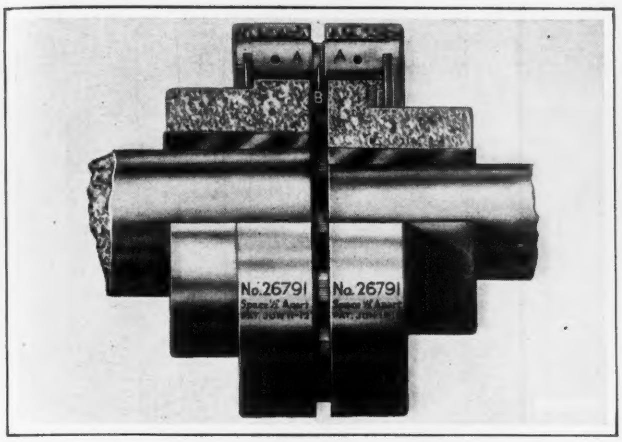


Fig. 9. Coupling with Axially Aligned Laminated Springs which engage Perforated Flanges

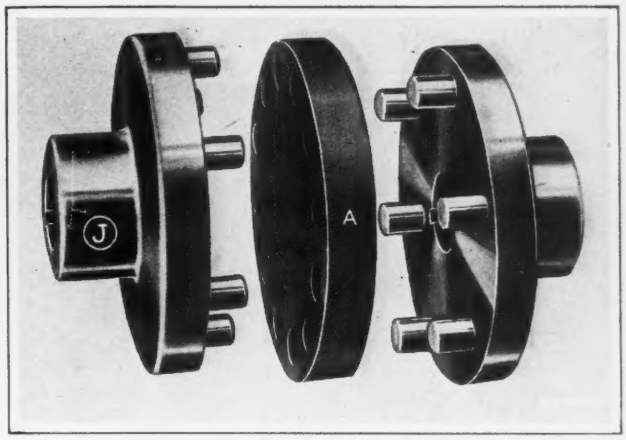


Fig. 10. Design having Pins in each Hub which engage an Intermediate Fiber Disk

tooth face and the spring that engages it. This coupling is strong, durable, and flexible in every way. (See coupling No. 3).

Fig. 2 shows a coupling that has an internal recessed hub and radial springs with keepers. The inner ends of these laminated springs *A* (see also Fig. 3) are firmly fixed in one hub, while the outer ends are encased in spring keepers *B*, journaled in an oil-tight ring *C*, which is attached to the other hub. The spring keepers slide endwise as well as rotate, and flexibility is thus provided for in every direction. This coupling is strong and durable, and is intended by the manufacturer for high-speed drives. (See coupling No. 4).

The coupling shown in Fig. 5 is provided with helical springs *A* which are mounted in circular recesses between internal and external hubs. A slight clearance is permitted the springs. This coupling is strong and flexible in every way, and its wearing surfaces are lubricated by a specially prepared lubricant furnished with the coupling. (See coupling No. 5).

Perforated Flanges and Intermediate Members

Perforated flanges and an interlocking leather disk are the characteristic features of the coupling shown in Fig. 6. This coupling has a co-axial floating leather disk *A* provided with lugs that interlock with the hub flanges. The elasticity of the disk and its lugs provides flexibility in every direction, which is augmented, to a considerable extent, by the clearance given the interlocking hubs. This coupling is strong, and wears well even though its wearing surfaces are not lubricated. It is a good example of what is termed an insulated coupling, although this term might also be applied to any coupling that employs insulating material, such as leather, rubber, or fiber, as a transmission element. (See coupling No. 6).

Fig. 9 shows a coupling having perforated flanges and axially aligned laminated springs. The perforated flanges receive keepers *A* containing the axially aligned laminated springs *B*. Each pin unit, consisting of a bundle of springs and two keepers, is extensible endwise. The bundles of springs can bend between the keeper supports, and the springs can also pivot on the keeper cross-pins; thus the coupling is flexible in every way. When a proper selection of spring is made to suit the load, a coupling of this type will give satisfactory results. For continuous drives, or if situated in wet or dirty surroundings, the pin units should be lubricated. (See coupling No. 7).

Couplings Having Pins and Bushed Hubs

A coupling of the pin type is shown in Fig. 8. This type differs in regard to the kind of bushings used. A coupling with a fiber-bushed hub which is adapted to receive pins mounted on the other hub, is strong, and wears well even though no provision is made for lubricating its wearing surfaces. All the flexibility is obtained through clearance, which is usually so slight as to eliminate all backlash and radial flexibility, but which is enough to permit a small amount of angular flexibility.

A coupling with a leather-bushed hub is strong, and wears well even though no provision is made for lubricating its wearing surfaces. Nearly all the flexibility is obtained through clearance, and the amount is usually so slight as to reduce angular and radial flexibility to a minimum.

A coupling with a rubber-bushed hub is strong, and wears well when the rubber bushings are lined with metal ferrules. Sometimes both the bushings and pins are mounted in each hub, so as to increase the total number slightly and strengthen the coupling proportionately. It will be noted that two planes of load-carrying surfaces are thus created,

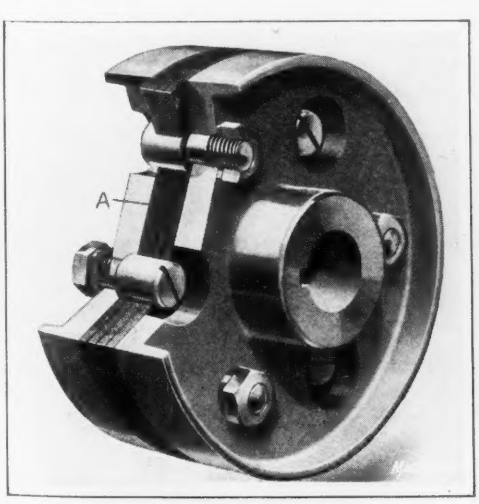


Fig. 11. Coupling with Pins engaging a Laminated Leather Disk

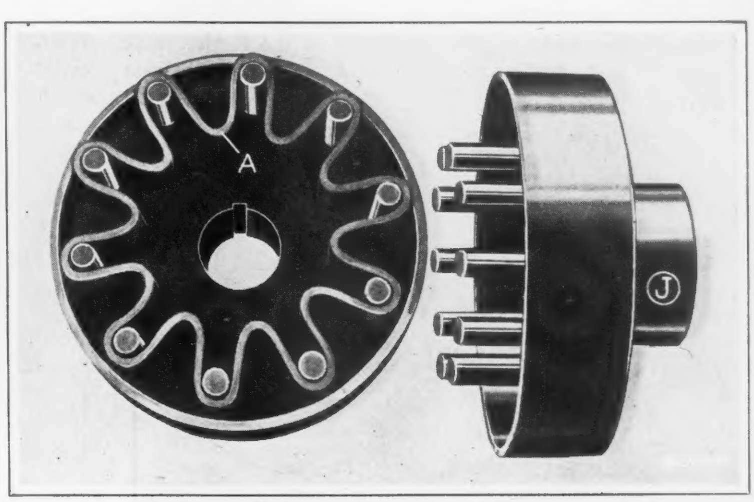


Fig. 12. Design of Coupling having a Leather Belt which connects with Pins in Opposite Hubs

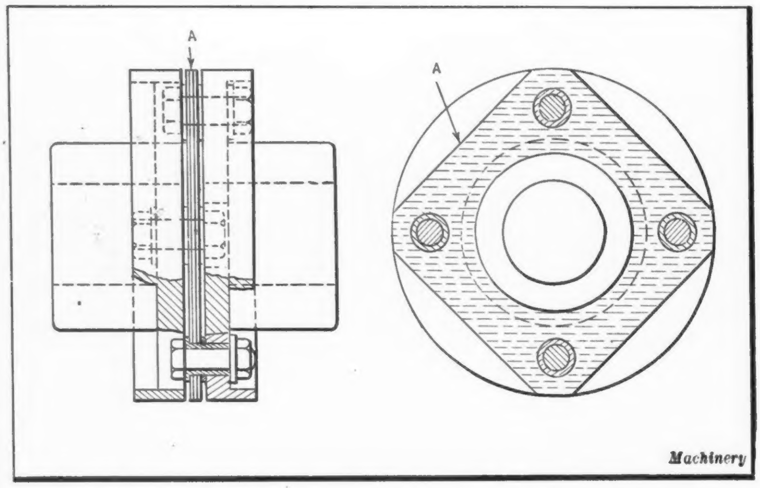


Fig. 13. Coupling of Laminated Steel Disk Construction with Four-point Drive

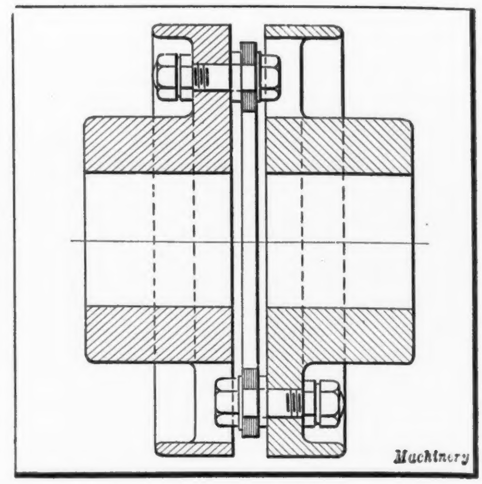


Fig. 14. Steel Disk Coupling with Six-point Drive

which would interfere with the usefulness of the coupling on an angle drive, but is not objectionable on regulation straight-line drives. (See couplings Nos. 8, 9, and 10).

Couplings Having Pins and Disks—Pins and a Flexible Band

Each hub of the coupling (shown separated in Fig. 10) is provided with pins which engage the perforations of a floating co-axial fiber disk *A*. This coupling is strong, and wears well even though no provision is made for lubricating its wearing surfaces. All the flexibility is obtained through clearance, which, of course, creates backlash. Some manufacturers allow the pins as much as 1/32 inch clearance, which insures flexibility in every direction.

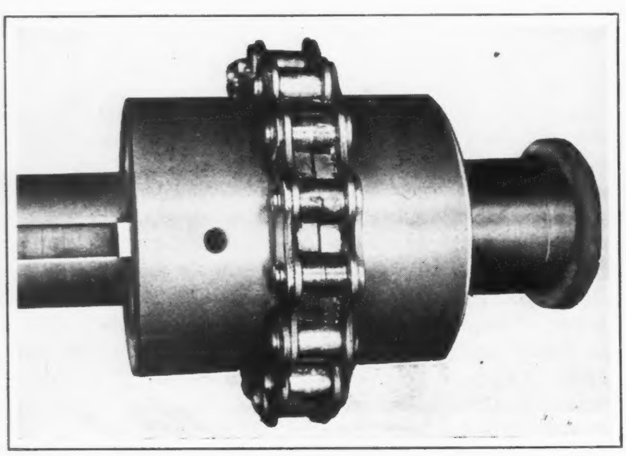


Fig. 15. Coupling of Sprocket and Chain Type

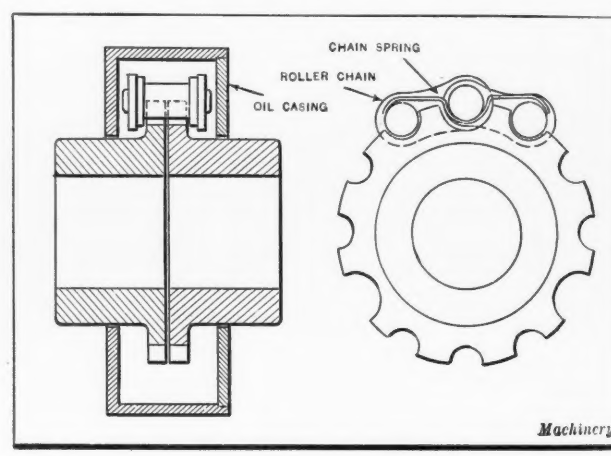


Fig. 16. Another Sprocket and Chain Design

The coupling shown in section in Fig. 11 is provided with pins in each hub, which engage the perforations of a floating co-axial leather disk *A*. The resiliency of the leather disk permits the coupling to "flex" in every direction, at least enough for most purposes. This coupling wears well, even though no provision is made for lubricating its wearing surfaces. (See couplings Nos. 11 and 12).

The coupling shown separated in Fig. 12 has a circle of pins mounted axially on each flange, the pins of one flange being placed concentric with the pins on the other flange, but on a circle of smaller diameter. The pin sets are usually laced together by an endless leather belt *A*, but a rope or leather links are sometimes used. Couplings of this type are very flexible, but possess a considerable amount of backlash which limits their use to constant-direction drives. They are often used where insulation is required. (See coupling No. 13).

Couplings Equipped with Steel Disks

The coupling shown in Fig. 13 has a laminated four-point drive disk *A* which is made of steel and is especially designed to permit a liberal amount of angular and axial flexibility. It also permits a slight amount of tangential

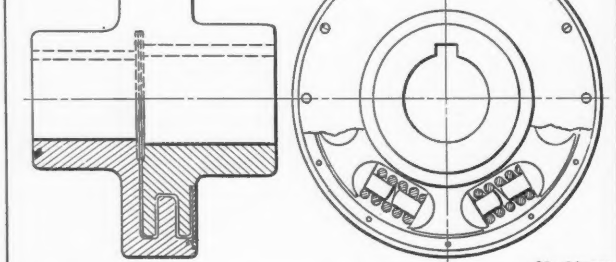


Fig. 17. Enclosed Design of Coupling of the Spider and Helical Spring Type

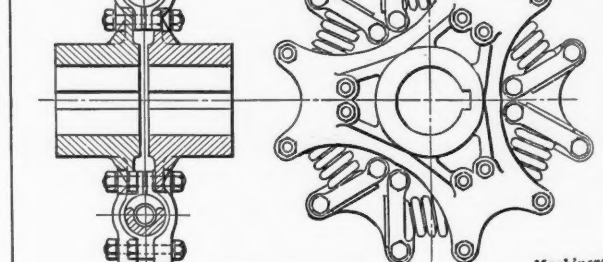


Fig. 18. Helical Spring Type of Coupling intended for Slow Speeds and Heavy Service

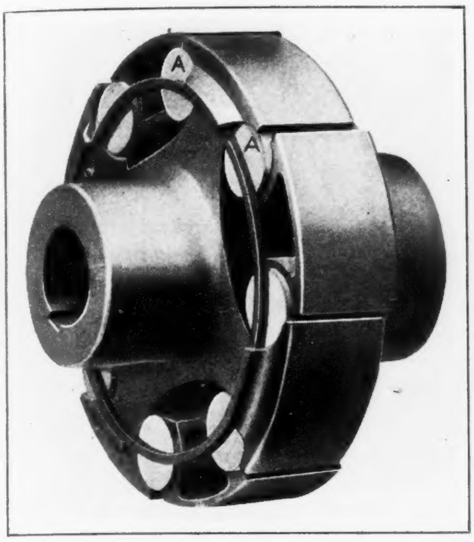


Fig. 19. Design having Interlocking Spiders and Solid Rubber Cylinders

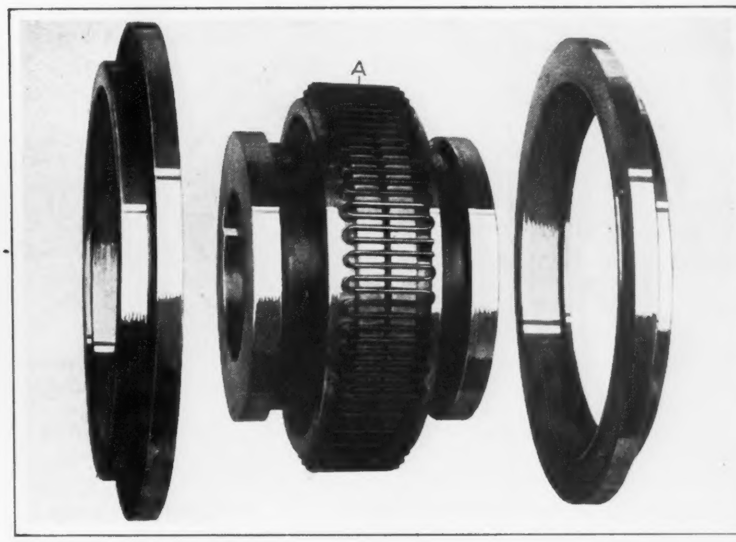


Fig. 20. Design of Coupling having Slotted Hubs, a Connecting Spring Grid, and a Housing

flexibility, but radial flexibility can be secured only when two couplings are mounted on a dummy shaft. This coupling is strong, has no wearing surfaces, requires no lubrication, and is especially durable, when properly installed.

The coupling shown in Fig. 14 has a laminated six-point drive disk which permits angular and axial flexibility and a small amount of tangential flexibility. Radial flexibility is obtained by mounting two couplings on a dummy shaft. This type of coupling is of strong construction, has no wearing surfaces, requires no lubrication, and is especially durable, when it is properly installed. (See couplings Nos. 14 and 15 in the table).

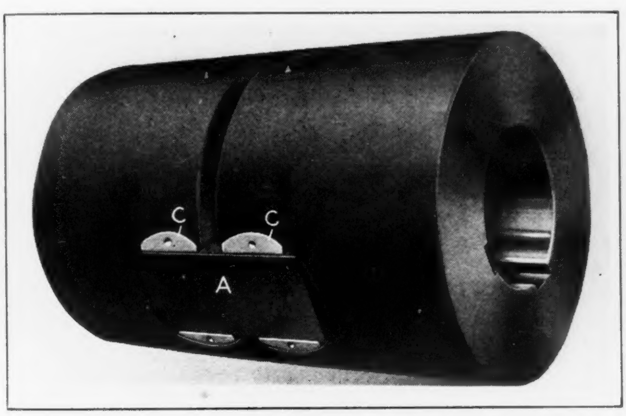


Fig. 21. Double Universal Joint adapted for Straight-line Drives

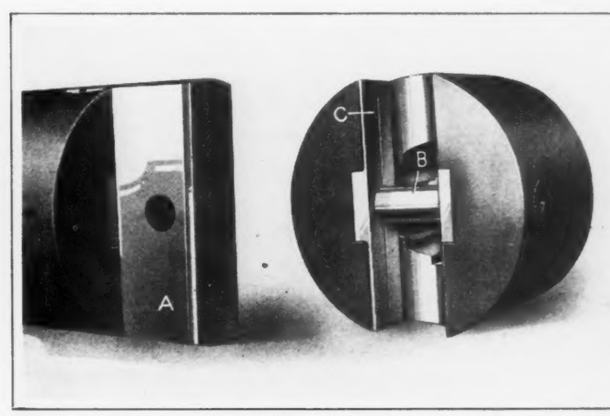


Fig. 22. Coupling shown in Fig. 21 with Parts separated

Couplings of Sprocket and Chain Type

The coupling shown in Fig. 15 is composed of two coaxial sprocket hubs connected by a roller chain. Flexibility is obtained through clearance given the chain on the sprockets. For engine drives the clearance should be less than for motor drives, unless chain springs (as described later) are used to take the slack out of the chain. An oil-tight housing is sometimes furnished with this coupling, which insures a continuous lubrication of all wearing parts and makes the coupling especially durable. When an oil-tight housing is not used, the chain should occasionally be lubricated, and in some cases cleaned and reversed (inside

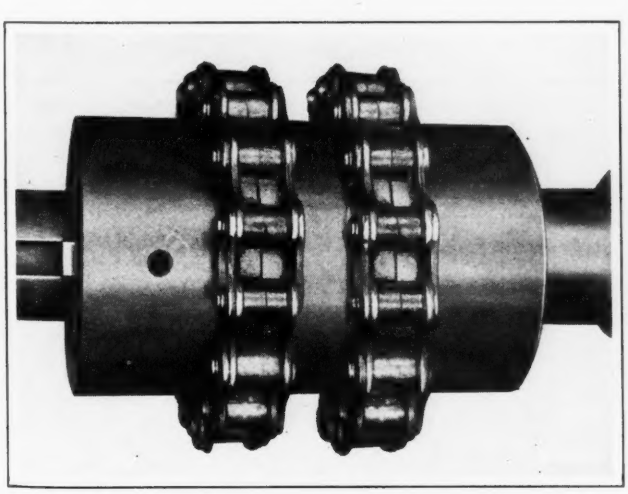


Fig. 23. Floating Double-sprocket Type of Coupling with Two Connecting Chains

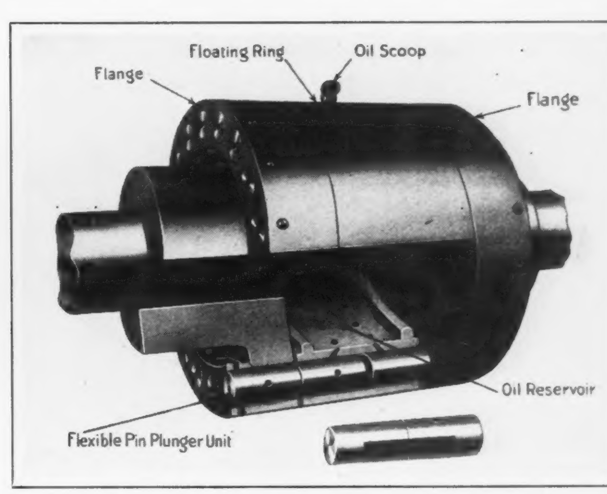


Fig. 24. Design having Floating Member and Axially Aligned Laminated Springs

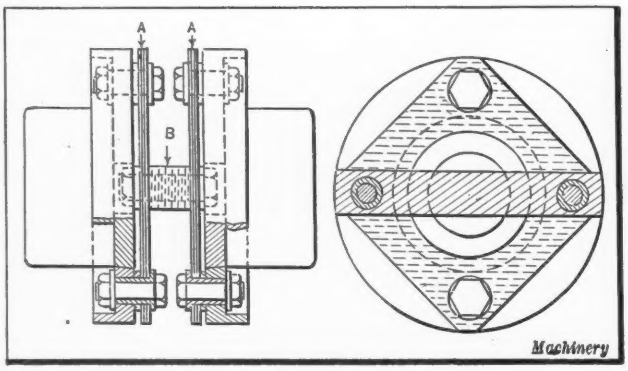


Fig. 25. Floating Type with Steel Disks which have a Four-point Drive

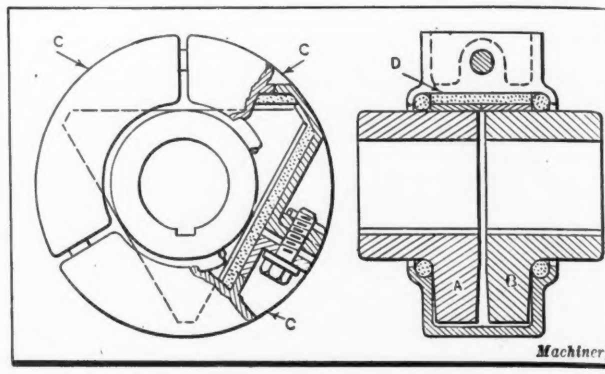


Fig. 26. Design having Floating Housing and Triangle-faced Hubs

placed outside). This coupling has no tangential flexibility unless chain springs are used; but otherwise it is flexible in every direction. The manufacturers of the sprocket and chain coupling in various countries differ in their opinion as to how it should best be constructed, as regards minor details.

The coupling shown in Fig. 16 is strong and flexible in every way, for the chain is loosely mounted on the sprocket hubs. Chain springs are used to take up the chain slack and render the coupling noiseless even when used in reversing service. The springs will last indefinitely if the coupling is properly designed. They give the coupling tangential flexibility, the torsional resiliency of which has a rising characteristic great enough to prevent the establishing of a resonance between the vibrations of the springs and the periodic torsional impulses of a connected unit.

For some classes of work a coupling of the sprocket and chain type can have its radial flexibility reduced to a minimum by using a snugly mounted chain. The design is the same as that shown in Figs. 15 and 16. (See couplings Nos. 16, 17, and 18).

Couplings Having Spiders and Helical Springs—Rubber Cylinders

The spider and helical spring type of coupling consists of interlocking spiders spaced apart by helical springs which drive one hub from the other. It is built with or without a grease-tight housing, the type with the housing being intended for slow speeds and heavy duty. Half the springs are in compression and half in tension in either direction of rotation. The design of coupling shown in Fig. 17 is entirely enclosed, thus eliminating the exposed revolving parts which are a source of danger in case of breakage or accidental contact with projecting parts. The design shown in Fig. 18 is particularly adapted to slow speeds and heavy service. There are two spiders connected by helical springs. One end of each spring is secured to an arm of the driving half of the coupling, and the other end to an arm of the driven half; thus the power is transmitted from one spider or section to the other by the compression and tension of the springs, half of the springs being in compression and half in tension in either direction of rotation.

The coupling shown in Fig. 19 consists of interlocking spiders spaced apart by solid rubber cylinders *A*. It is flexible in every way, has no friction surfaces, and is intended for fairly high speeds and light service. (See couplings Nos. 19 and 20).

Toothed Hubs, Spring Grid, and Housing

Fig. 20 shows a coupling which consists of two co-axial disks or hubs having teeth on their periphery adapted to engage axially extending members of a spring grid *A* which encircles the disks. This coupling is strong and flexible in every way, and is enclosed in an oil-tight housing. The teeth are shaped so as to reduce the free length of the spring whenever a certain torsional load is exceeded, thus keeping the fiber stress within a safe limit, and also tending to prevent synchronous vibrations. (See coupling No. 21).

Universal Joints

Universal joints are constructed in a great many ways to suit various needs. Their main field is angle drives, for which they are especially adapted; but they are also used on straight-line drives. Some couplings of this type are very strong, but care should be used not to overload their bearing surfaces even when they are well lubricated.

A single joint possesses no tangential or radial flexibility, and usually no axial flexibility. A splined shaft may be used with the coupling when axial flexibility is desired. A single joint may be used on a three-bearing straight-line drive or on an angle drive, but when used on an angle drive it will not transmit a uniform shaft motion. Two joints can, however, be connected by a dummy shaft and be arranged so as to transmit a uniform shaft motion. Or the same result may be obtained by a properly arranged double universal joint; moreover, a combination of this sort will provide a liberal amount of radial flexibility.

Fig. 21 shows a double universal joint constructed specially for straight-line drives. This joint (which is shown disconnected in Fig. 22) consists of a floating member *A* journaled at each end on pins *B*, which are mounted in two circular bearing blocks *C* on opposite sides of the member *A*. These blocks are, in turn, journaled in circular slots in the

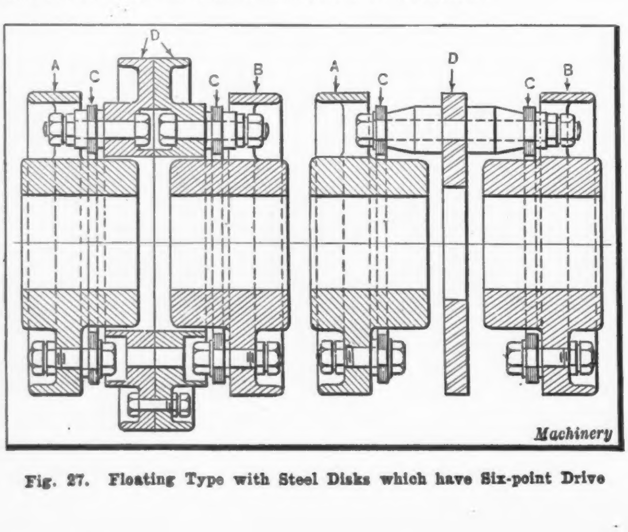


Fig. 27. Floating Type with Steel Disks which have Six-point Drive

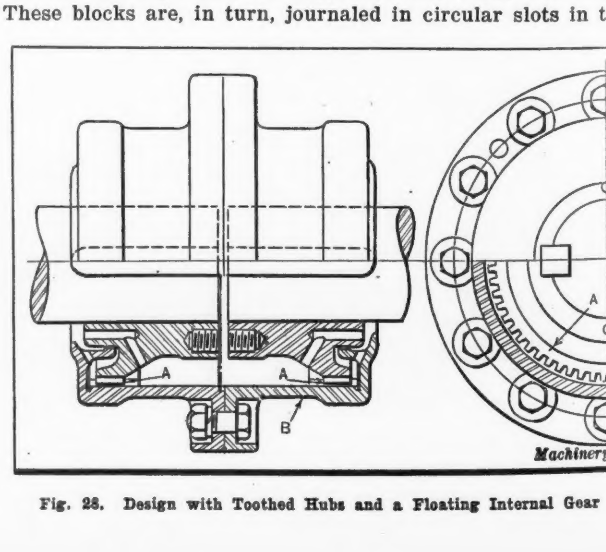


Fig. 28. Design with Toothed Hubs and a Floating Internal Gear

ends of the hubs, so that each single joint provides a certain amount of angular flexibility, giving the coupling as a whole the necessary radial flexibility. This type of coupling also has a liberal amount of axial flexibility. (See coupling No. 23).

Couplings Having Floating Members

The coupling shown in Fig. 23 has a floating double sprocket and two connecting chains, which permits flexibility in every direction. When there is radial misalignment, this coupling is especially adapted for heavy-duty work, since angular flexibility only is present at the points where the floating sprocket is connected with the others by the chains. This type of coupling can be installed after the shafting is in place. An oil-tight casing may be supplied so that thorough lubrication of all wearing parts is maintained. (See coupling No. 24).

Floating member and axially aligned laminated springs are utilized in the coupling shown in Fig. 24. This coupling consists of two flanged hubs between which is interposed a floating ring connected to both flanges by flexible laminated spring pins. One of these spring pins is shown in detail in the lower part of the illustration. This coupling is strong, flexible in every way, and is intended primarily for continuous-process drives from 200 horsepower up. Continuous lubrication is provided by an enclosing oil casing. (See coupling No. 25).

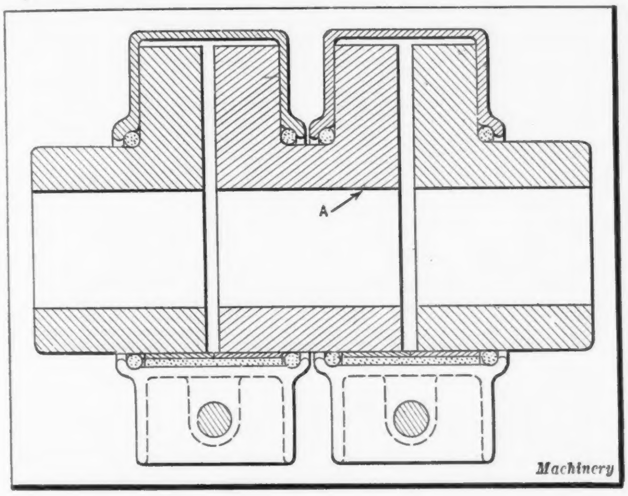


Fig. 29. Coupling having Two Triangle-faced Hubs and a Floating Triangle-faced Intermediate Member

The coupling shown in Fig. 25 is composed of two flanged hubs, each of which has a four-point drive, laminated steel disk *A* attached to it. The disks are connected by a floating member *B*, and are especially designed to permit a liberal amount of angular, radial, and axial flexibility as well as a slight amount of tangential flexibility. The coupling is strong, has no friction surfaces, requires no oil, and is especially durable when properly installed. (See coupling No. 26).

Fig. 27 shows two couplings which embody the same general principle of construction. These couplings have two flanged hubs, *A* and *B*, each of which has a six-point drive, laminated steel disk *C* attached to it. The disks are, in turn, connected by a floating member *D*. This coupling permits angular, radial, and axial flexibility, as well as a slight amount of tangential flexibility. It is strong, has no friction surfaces, requires no oil, and is especially durable, when properly installed. (See coupling No. 27).

The coupling shown in Fig. 28 consists of two internal gears *A* enclosed in a floating internal toothed oil-tight housing *B* with which they mesh. A small amount of backlash is permitted the teeth in order to provide flexibility, but the oil renders the coupling noiseless even under reversing service. The coupling has no tangential flexibility, but otherwise it is flexible in every way, and is strong and durable. (See coupling No. 28).

The coupling shown in Fig. 26 consists of two triangle-faced hubs *A* and *B* and a three-piece adjustable housing *C* adapted to enclose and engage the bearing surfaces of the triangles and transmit power from one hub to the other. The housing rests on leather liners *D* which permit flexibility in every direction and cushion sudden shocks; but the greater amount of flexibility is provided by a floating of the housing as a whole. The housing length equals one-half the coupling length, so that it functions like a dummy shaft, its center line intercepting the center line of the connected shafts at the transverse center line through the load-bearing surfaces of the triangles. For this reason, this coupling is classed as a double type. The leather liners are supplied with or without a steel facing, depending upon the size of the coupling and its use. Grease is not essential in the housing sections except when the liners are steel-faced.

Radial flexibility in this coupling is controlled by means of the housing bolts. As the housing is more tightly cinched, the radial flexibility is proportionately lessened, so that the coupling will center the free end of a shaft and can be used on a three-bearing outfit. When the coupling is intended for high speeds, accurate balance is obtained by a selection of equal weight sections for the housing, so as to insure freedom from noise and vibration. This coupling is strong and durable. (See coupling No. 29).

Several smooth-exterior forms of this triangular coupling, including insulated types, are constructed without sectional housings. A coupling consisting of two triangle-faced hubs having a floating triangle-faced transmission member *A* mounted between them is shown in Fig. 29. Two housings are used, and the radial flexibility of the unit is thus greatly increased. This coupling can be installed after the shafting is in place. (See coupling No. 30).

* * *

WASTE IN THE INDUSTRIES

In his address before the Distribution Conference, recently held in Washington, Mr. Hoover called attention to the great waste of labor and materials that takes place in industry continually, due to lack of appreciation of economic factors in production and distribution. He pointed out that in speaking of waste he did not mean waste in the sense of wilful waste, but economic waste, which is the natural outgrowth of a competitive system lacking sufficient coordination. He stated that he did not mean the waste that any single individual can correct by his own initiative, but the waste that can only be prevented by collective action. The kinds of waste referred to were catalogued as follows:

1. Waste from the speculation, relaxation of effort, and extravagance in boom periods, together with the great waste from unemployment and bankruptcy which comes with the inevitable slump. 2. Waste due to an excessive seasonal character of production and distribution. 3. Waste caused by lack of information as to national stocks and of production and consumption, with the attendant risk and speculation. 4. Waste from lack of standards of quality and grades. 5. Waste from unnecessary multiplication of sizes and varieties. 6. Waste from the lack of uniformity of business practices and terms, with resultant misunderstandings, frauds, and disputes. 7. Waste due to inadequate transportation facilities and terminals, and to inefficient loading and shipping, and unnecessary haulage. 8. Waste due to lack of system in marketing with attendant gluts and famines. 9. Waste due to too many links in the distribution chain, and too many chains in the system. 10. Waste due to bad credits. 11. Waste due to destructive competition of people who are exhausting their own capital through their lack of understanding of the fundamentals of the business in which they are engaged. 12. Waste due to enormous expenditures of effort and money in sales promotion, without enough basic information on which to base the sales effort. 13. Waste due to unfair practices of a small minority. 14. Waste in the use of materials, due to lack of fire protection and to preventable traffic accidents.

SECTION MODULUS OF UNSYMMETRICAL SECTIONS

By ELMER LATSHAW

The usual method of finding the section modulus about the axis x–x of the familiar unsymmetrical sections shown in Figs. 1, 2, and 3, is somewhat tedious, and where the design is in the process of development, it may be necessary to calculate this value several times before an area is obtained that will give the desired strength and be of satisfactory weight. In the following will be derived a simple formula, which gives the approximate section modulus of these and similar sections. With the aid of tables of rectangular areas and section moduli of rectangular sections, the formula considerably reduces the computations necessary.

For computing the section modulus of the sections shown in Figs. 1 and 2, these sections may be rearranged to the same form as that in Fig. 3. Then the section is divided, as shown in Fig. 4, into two areas A and B. The total area C is equal to $A + B$. Axis x–x indicates the center of gravity of the entire area C. It will be noticed that the upper end of area B ends at the middle of area A.

Now, taking the moment about axis y–y, we get

$$\frac{Ah + \dfrac{Bh}{2}}{C} = h - \frac{Bh}{2C} = b \qquad (1)$$

Taking the moment about axis z–z we get,

$$\frac{Bh}{2C} = a \qquad (2)$$

These values of a and b are approximate on account of the center of gravity of area A not being exactly in the center of width t, but when t is small in proportion to h, the approximation is very close.

The moment of inertia I_x of the total section about axis x–x is found by the formula,

$$I_x = \frac{At^2}{12} + \frac{Bh^2}{12} + Aa^2 + B\left(b - \frac{h}{2}\right)^2$$

However, the term $\dfrac{At^2}{12}$ may be omitted as, since t is usually small, this term is negligible, and in the following calculations it is omitted.

Substituting the equivalent values of a and b given in Equations (1) and (2), and omitting $\dfrac{At^2}{12}$ we have:

$$I_x = \frac{Bh^2}{12} + \frac{AB^2h^2}{4C^2} + B\left(\frac{h^2}{4} - \frac{Bh^2}{2C} + \frac{B^2h^2}{4C^2}\right)$$

which reduces to

$$I_x = \frac{Bh^2}{3} - \frac{B^2h^2}{4C} \qquad (3)$$

Now as b is the distance from the center of gravity to the most remote fiber, the section modulus Z_c may be found by the formula:

$$Z_c = \frac{\dfrac{Bh^2}{3} - \dfrac{B^2h^2}{4C}}{h - \dfrac{Bh}{2C}} = \frac{Bh}{6}\left(\frac{4A + B}{2A + B}\right) \qquad (4)$$

But $\dfrac{Bh}{6}$ is the section modulus of area B about its own axis, and so denoting this section modulus as Z_b,

$$Z_c = Z_b\left(\frac{4A + B}{2A + B}\right) \qquad (5)$$

If areas A and B are equal, Formula (5) may be still further simplified to

$$Z_c = \frac{5Z_b}{3} \qquad (6)$$

As an example of the use of Formula (5), let us figure the section modulus of a 6- by 4- by 1/2-inch structural angle, considering the 6-inch leg vertical, as shown in Fig. 5. Then

$$Z_b = \frac{Bh}{6} = \frac{5.75 \times 0.5 \times 5.75}{6} = 2.755 \text{ inches}^3$$

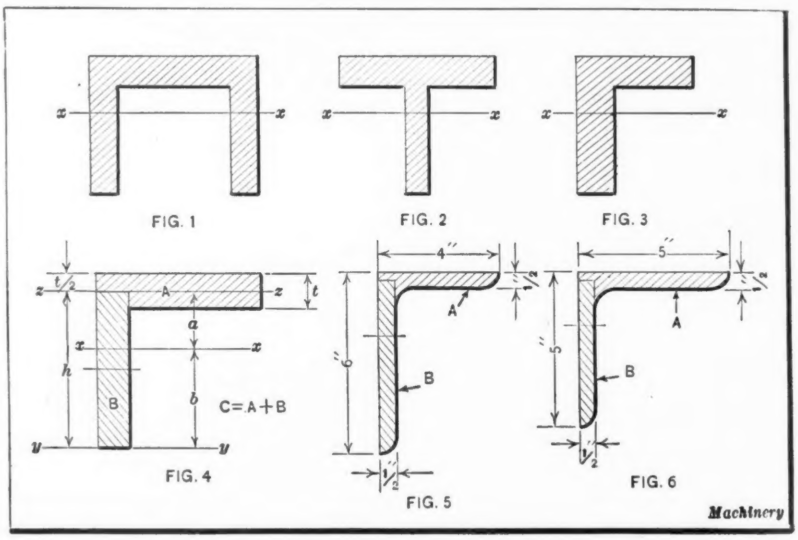
$$A = 1.875 \text{ square inches}$$
$$B = 2.875 \text{ square inches}$$

Now according to Formula (5),

$$Z_c = 2.755\left(\frac{7.5 + 2.875}{3.75 + 2.875}\right) = \frac{2.755 \times 10.375}{6.625} = 4.31 \text{ inches}^3$$

The value given in structural handbooks for this angle is 4.33 inches³, and so the formula gives a difference of only about 1/2 per cent.

As an example of the application of Formula (6), the section modulus of a 5- by 5- by 1/2-inch structural angle will be determined. Then



Diagrams illustrating Simplified Method of determining the Section Modulus of Common Unsymmetrical Sections

$$Z_b = \frac{Bh}{6} = \frac{4.75 \times 0.5 \times 4.75}{6} = 1.88 \text{ inches}^3$$

and

$$Z_c = 1.88 \times \frac{5}{3} = 3.13 \text{ inches}^3$$

Structural handbooks give 3.16 inches³ for this value, which shows only a 1 per cent deviation by means of this method.

The most important application of these formulas is in determining the strength of castings, forgings, pressed parts, and structural angles sheared to sizes other than given in handbooks. It is not necessary for the two legs of a section to be of the same thickness. The greatest approximation made in the derivation of these formulas is in dropping the term $\dfrac{At^2}{12}$, but if t is small, the deviation from the correct section modulus will be well within practical limits of accuracy. It is well to note that this approximation is on the safe side.

* * *

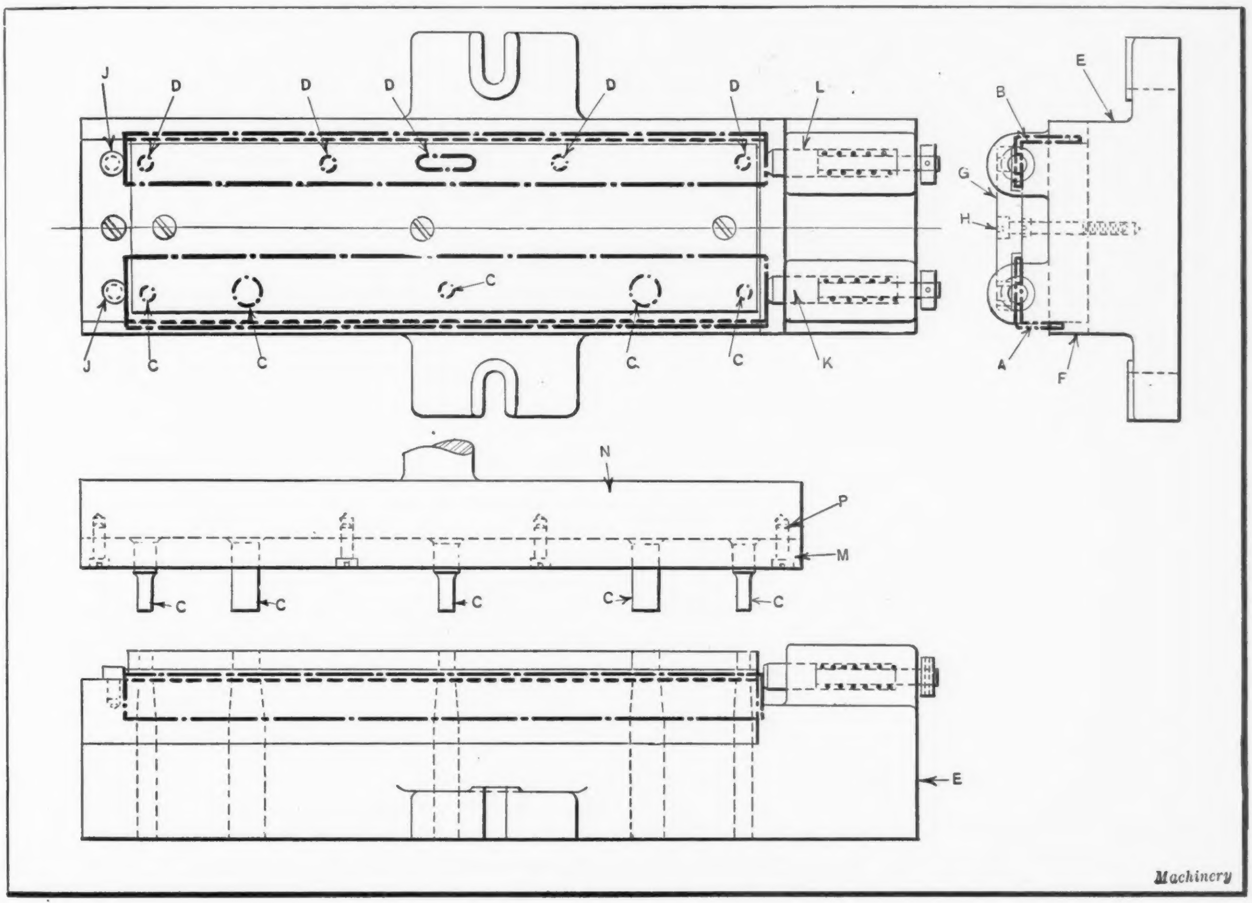
The present exportation of 380,000 motor vehicles annually from the United States is equivalent to the demand for motor vehicles of twenty-four of the smaller states in the country. As nearly as can be determined, the United States exports to foreign countries approximately the same number of cars unnually as are built in the entire world outside of the United States.

TWO-PURPOSE DIE

By F. SERVER

The expense involved in making die-shoes often constitutes a considerable part of the total cost of a die. In many instances the cost can be materially reduced by combining the tools for two different operations in the same die-shoe and punch-holder. Care must be exercised, however, to avoid having the punches of one die in a position that will endanger the fingers or hand of the operator when placing work in the active part of the die. In the accompanying illustration is shown a good example of the two-purpose type of die.

It must not be assumed that two different parts are punched in the die at one time. Although it might be possible to punch two pieces simultaneously, it is not practical to do so, the regular practice being to set up the die so that the work at *A* can be put in position at the side nearest the operator, or to reverse the die so that the work at *B* will be in the operating position. The punching operation on the parts shown by the heavy dot-and-dash lines at *A* and *B* consists of piercing a group of holes in the wide angle side at *A* and in the narrow side of the angle piece at *B*. There are five punches at the front side of the die and five at the rear side, including the punch for the elongated slot near the center. The punches in the die at the front side are indicated by letters *C* and those in the rear by letters *D*.



Die provided with Two Sets of Punches

The die consists of the cast-iron shoe *E* to which the die-block *F* is secured by means of screws *H*, the stripper plate *G* being open at the front and rear sides so that the work *A* or *B* can be slipped into the position shown by the dot-and-dash lines and held against the side of the die by hand. At the left-hand end of the die-shoe are two pins *J* which act as stops for the work, while the spring pins *K* and *L* serve to keep the work in contact with the stop-pins. The punches are held in a plate *M*, which fits into a slot in the holder *N*, where it is held in place by screws *P*.

One feature of the die that might be objectionable in some cases is that the work is located from opposite ends when piercing the two groups of holes. In this instance, however, the group of holes on one side of the angle piece was not required to be accurately positioned with respect to the group of holes on the other side, thus permitting the locating pins to be placed at one end of the die. This feature made it possible to cut down the length of the die and simplify its construction.

* * *

MACHINERY INDUSTRY IN SWEDEN

According to information published by the Department of Foreign and Domestic Commerce, the machinery industry in Sweden showed an improvement during the first six months of 1924. The number of men employed in this industry increased by over 17 per cent, and the number of working hours by over 15 per cent from July 1, 1923, to July 1, 1924. Eight machine shops in Sweden were engaged during 1924 on Russian contracts for machinery, these shops employing during the entire year 1760 workers on these orders. In addition, three other plants worked on Russian contracts part of the year. The industrial crisis in Germany has caused German manufacturers to make even greater efforts than before in Sweden, and especially where large orders are concerned, they are competing actively. For a time competition from Germany decreased as a result of the stabilization of German currency, but the pressure of German competition has not been relieved to the extent hoped for, partially because wages in Germany are considerably lower than in Sweden.

* * *

A survey made by the National Automobile Chamber of Commerce shows that the largest number of automobiles, in proportion to population, are used in towns of from 1000 to 5000 inhabitants. In towns of this size there are, on an average, 230 cars per 1000 inhabitants. The number of cars per 1000 inhabitants then gradually decreases until there are 85 cars per 1000 inhabitants in cities with populations of over 100,000.

Making Kelly Reamers

By CHARLES O. HERB

STRENGTH, lightness, and accuracy are three characteristics especially desirable in boring and reaming tools of the type used in machining, at one time, the bearings of automobile crankcases and similar parts. In tools of this type made by the Kelly Reamer Co., Cleveland, Ohio, alloy steels are used throughout, so as to obtain strength in combination with comparatively light weight designs. Also by making the long cutter-holding bars of alloy steel, elasticity is obtained, which eliminates the possibility of the bar taking a permanent set that would destroy the alignment of the cutters. This article will describe some of the methods used in the plant mentioned.

Design of Boring and Reaming Tools

For the benefit of those not familiar with the designs of Kelly tools, a few of the principal features will be briefly mentioned before proceeding with a description of the manufacturing processes. There are two main styles of tools, one in which the cutter blades are contained in a body *A*, Fig. 1, which, in turn, is mounted in a transverse slot in the boring-bar, while in the second or "rigid bar" style, the entire tool, with the exception of the blades themselves and their adjusting and locking screws, is one integral piece. This article will deal almost entirely with the first style.

There are several ways of securing the reamer body *A* in the bar. In the design illustrated, the body is rigidly located by means of a key *B* and a taper lock-screw *C*. The locating key is adjusted through screws *D* until the cutter blades *E* are central with the axis of the bar, after which the screws are sealed to guard against the setting being destroyed when the bar is put into use. Cutter blades *E* are held at an angle of 45 degrees with the axis of the bar. They are adjustable by means of screws *F*, and are held in set positions by means of gib bushings which are tightened and loosened through screws *G*. This method of assembly is used when float-reaming is not advisable.

In the standard floating construction, the taper lock-screw *C* alone is relied upon to locate the cutter body in the bar, hardened side plates being attached to the bar at the rear side of the reamer body to reduce the slot size to the width of the body. The taper lock-screw is loosened to allow lateral movement of the cutting unit. When the same bar is used for both roughing and finishing operations, a round taper wedge is employed in combination with the locating key to facilitate quick interchanging of the reamer bodies. Long bars of all three constructions have hardened inserted strips to guide the bar through the fixture bushings and hold it rigidly during a boring or reaming operation.

Making the Cutter Bodies and Blades

The reamer bodies are made from stock that is about 0.020 inch thicker than the finished thickness, and this stock comes in lengths that are sawed up into pieces about 1/8 inch longer than the finished bodies. This excess metal provides for obtaining a good and accurate finish. One of the first operations on a reamer body is to mill the slot for the locating key *B*. About seven or eight bodies are held at one time in the vise of a milling machine for this operation, the vise being so located as to insure that the slots will be produced approximately central. The body is then fastened to a special arbor on which it is held centrally by means of a key that enters the locating key slot, and while on this arbor edges *a* are turned to the desired diameter. The next step consists of drilling and reaming the hole for the locating screw *C*, on a three-spindle drilling machine. This hole must be produced in a certain relation to the key slot, and so the part is held in a jig in which it is located from this slot and clamped from the opposite side. Two different sized drills are used in the first two spindles of the machine, and a taper reamer in the third.

The two sides of the body are next ground to the specified thickness within 0.005 inch plus or minus, on a surface grinding machine equipped with a magnetic chuck. Then slots are milled for blades *E* by using dovetailed end milling cutters on which the cutting edge is at an angle of 10 degrees. These slots are usually milled at an angle of 45 degrees with the center line of the body, but in some cases the angle is 55 degrees. Care must be taken to see that the first body of a lot is properly milled, after which the remainder can be run through without checking.

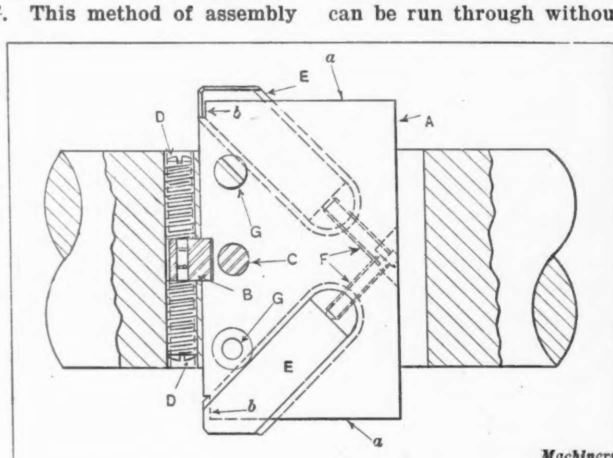


Fig. 1. Sectional View showing One Method of assembling the Reamer Bodies in Bars

In the next step, which consists of drilling and counterboring holes for the supporting screws *F*, a fixture is employed in which the work is reversed for producing the second hole after the first has been finished. This jig has a slot in which the piece is seated at the proper angle for the operation. The holes for the gib bushing controlled through screws *G* are next drilled and counterbored. For this operation the work is held in a jig in which it is located by means of a key which engages the locating key slot in the body. The

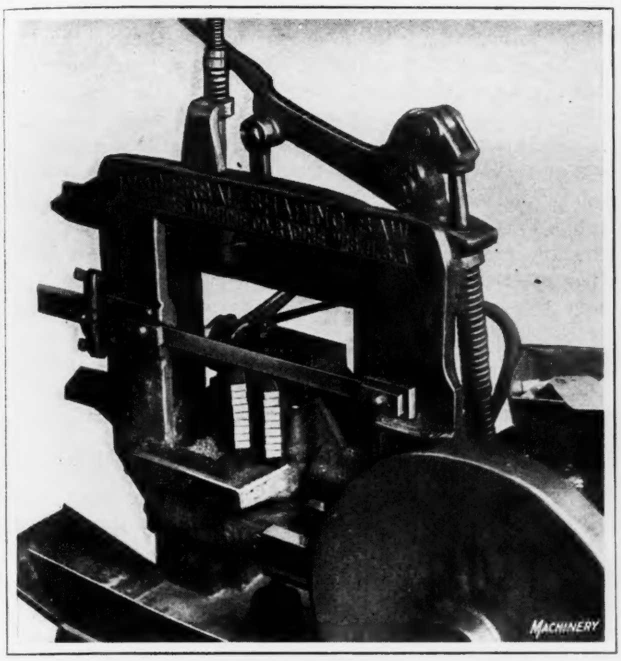


Fig. 2. Sawing Machine arranged with Special Fixture designed to reduce Excess Stock on Blades to a Minimum

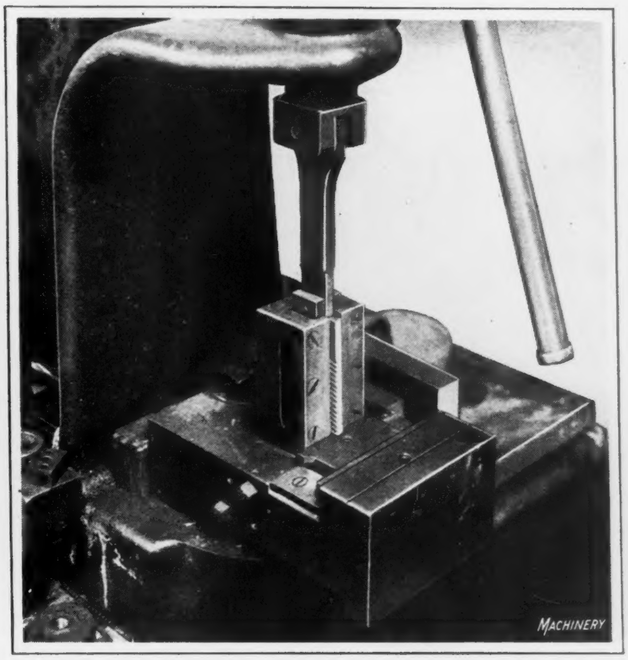


Fig. 3. Broaching the Locating Key Slot to Size in the Reamer Body after the Blades have been assembled

blade clearances *b* are next milled. After this, no more operations are performed on the bodies until the blades have been assembled.

The high-speed steel from which the cutter blades are made comes in 10 and 12 foot lengths. To conserve material, the stock is cut up into such lengths that two blades are produced by cutting through the middle of the piece at an angle of 45 degrees. A special fixture has been designed to hold eighteen or twenty pieces in a sawing machine for this operation, and so approximately forty blades are produced at one time. The arrangement of this fixture is illustrated in Fig. 2, from which it will be seen that the blades are locked in place by tightening an overhead screw. This simple shop kink has resulted in a considerable saving of high-priced scrap.

From the saw, the blades are sent to the heat-treating department for hardening and tempering. To obtain uniform results during heat-treatment, the blades are held in receptacles which prevent them from touching one another. They are next surface-ground in quantities, and then ground individually on the edges to the proper width. After this operation, they go to the inspection department for a scleroscopic test and to determine whether the thickness and width are correct and whether the character of the edges is satisfactory. From this inspection the blades are sent to the assembling benches.

Assembling the Cutter Units and Finish-grinding the Blades

When the bodies reach the assembling bench, the dovetailed slots are cleaned of all burrs, the holes for screws *F*, Fig. 1, tapped, and the blades, gib bushings, and screws assembled. The ends of the blades are then rough-ground, and the size, firm name, etc., stamped on the body, after which the sides of the body with the blades assembled are surface-ground to the required thickness within a tolerance of 0.0005 inch. Then the front edge of the body, where the locating key slot is situated, and the back edge are ground to a gage. Next the locating key slot is broached to size under an arbor press set up as shown in Fig. 3, the body being located sidewise between two hardened blocks.

In the next step, which consists of grinding the blades to the desired diameter, the assembled cutter unit is placed in a fixture which is mounted between the centers of a cylindrical grinding machine, as shown in Fig. 4. The locating key slot in the body is again used to locate the work in the fixture, and a wedge-shaped clamp is tightened to hold the work in place. The blades are ground to the finished size by simply oscillating the fixture to bring both

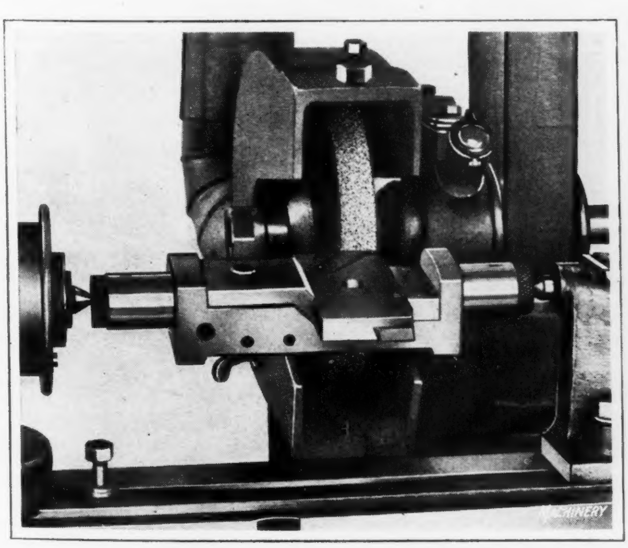


Fig. 4. Grinding the Reamer Blades to the Specified Diameter and Lead Angle

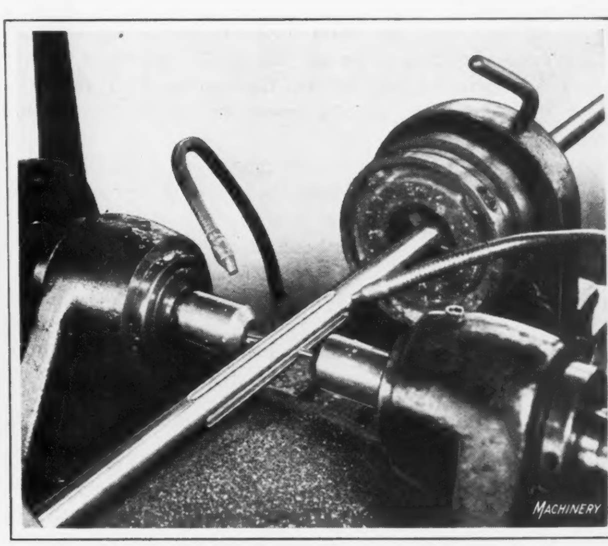


Fig. 5. Milling the Pilot Strip Grooves in the Bar on a Duplex Slot Milling Machine

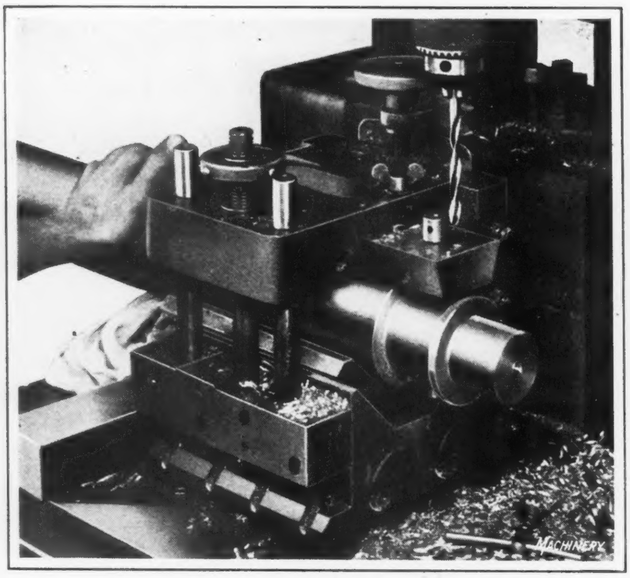


Fig. 6. Jig used in drilling and tapping the Locating Key Adjusting Screw Holes and the Taper Lock-screw Hole in Bars

blades in contact with the wheel. There are two holes in the fixture to receive the headstock center, one of the holes being located slightly off the axis of the fixture so as to provide a radial relief in grinding the blades, and the second one about 3/32-inch off center to provide for grinding the clearance known as the "lead angle." Users of Kelly reamers can obtain this type of grinding and relieving arbor for keeping the cutting edges in working condition.

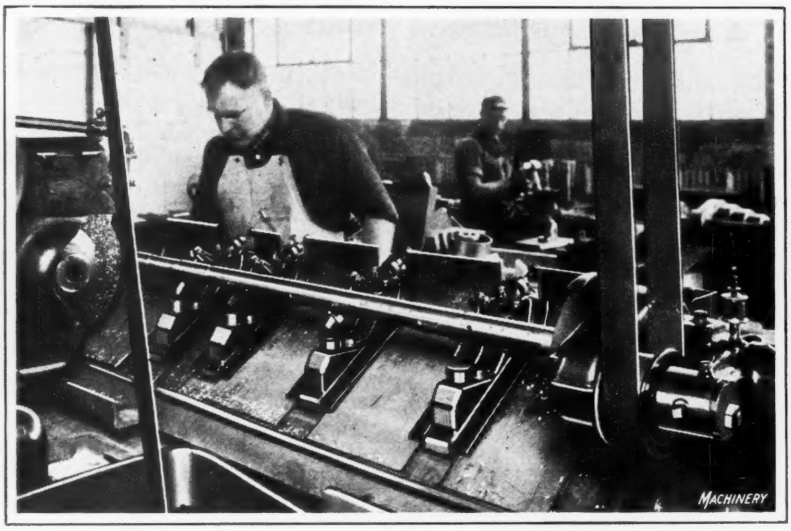


Fig. 7. Grinding the Bar and the Guide Strips on a Cylindrical Grinding Machine

At this point a lip is sometimes ground on the blade with the body held on a magnetic chuck. However, whether this is done or not, the units are taken to a tool grinder to have the face of the blade ground at an angle of 5 degrees, a cup-wheel being employed for this operation. Then the table of this machine is set at an angle of 45 degrees for grinding away the outer front corner of the blades. These finish-grinding steps are not conducted until definite orders are being filled, as the dimensions and angles to which the blades are ground frequently vary with the customer's needs.

Gages are used throughout the manufacture of the bodies and blades, to see that the thickness of both the bodies and blades, the dimensions of the locating key slot, and the dimensions and angles of the blade-slots, etc., are within the prescribed limits. Also in the inspection department all important dimensions and angles are again checked, as well as the hardness of the blades. Blades and bodies are milled in various sizes to standard dimensions, and must be interchangeable with parts of the same rated size.

Important Operations on the Bars

Whereas the cutter units can usually be taken from stock and quickly ground to fill an order, it is generally necessary, except with slotted and rigid standard turret bars, to put the bars through the shop on individual orders, because the lengths and diameters must be made to suit individual conditions. The bars are made from hot-rolled chrome-manganese steel. They are first centered and turned in an engine lathe. Bars to be hardened are then carburized, given a special heat-treatment to obtain a tough core, and then the pilot diameters are casehardened. Certain portions of the bar on which operations are later to be performed are left soft. Following the heat-treatment, one of the important operations is the milling of the slots to receive the reamer bodies. After the slotting, bars that are to be equipped with hardened strip pilots are spline-milled to receive the hardened strips. The heading illustration shows a bar of the multiple cutter type, over 80 inches long and about 1¾ inches in diameter at the largest section, being put through this operation. Three reamer body slots and four series of pilot strip grooves were milled in this particular bar. One of the most important points in this operation is to see that the various slots and pilots are spaced properly along the bar.

These operations are performed on a Garvin duplex slot milling machine, with the work held in an indexing chuck and special tailstock which are mounted on the machine table. End milling cutters are used in both machine spindles to work from opposite sides at the same time, as illustrated in Fig. 5, which shows cuts being taken on the pilot strip grooves. These grooves are milled in series of four, spaced equidistantly around the bar.

In milling a reamer body slot, it is first roughed out on the Garvin machine, and then with the work mounted in a lathe provided with a special set-up, a cutter somewhat larger in diameter and with a long neck is fed through the bar at the rear end of the slot, and up along the slot at the middle of the bar so as to clean it out. The slot is next broached out in a horizontal broaching machine to square up the front end and to size it. After this operation, the bar is placed between centers and checked with a master to see that the front end of the slot is at right angles to the axis of the bar. If this were not so, one of the reamer blades would cut in advance of the other.

From this checking the bar is sent to the drilling depart-

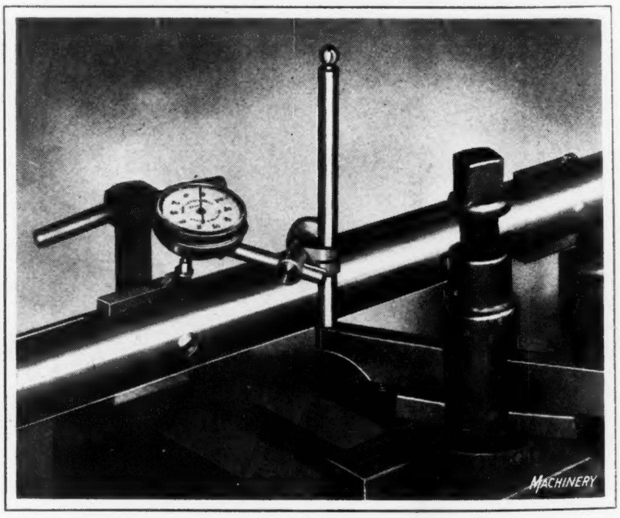


Fig. 8. Checking the Centralization of the Reamer in Relation to the Axis of the Bar

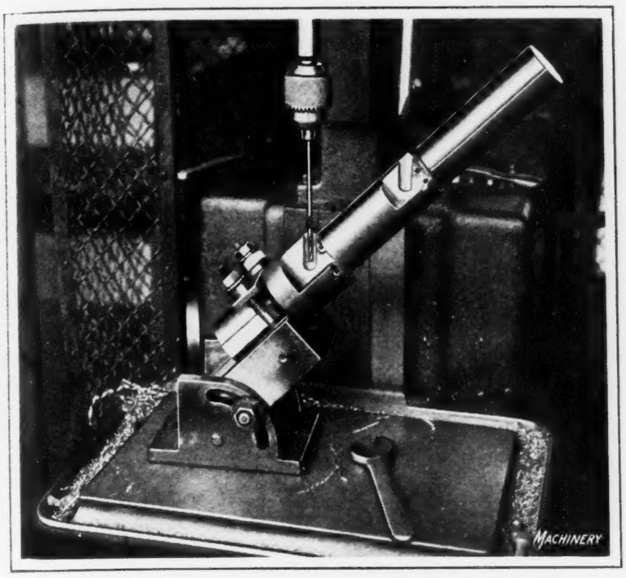


Fig. 9. Angular Jig used in drilling and tapping the Blade Adjusting Screw Holes in Rigid Bar Tools

ment for drilling and tapping the locating key adjusting screw holes directly in front of each reamer body slot and also the hole that receives the taper lock-screw. The latter hole is drilled straight in the bar and taper-reamed in the body. Both operations are performed with the part held in the jig shown in Fig. 6; in this illustration a bar of special design is shown. In drilling and tapping the locating key adjusting screw holes, the work is located radially in the jig, as shown, by means of a plug which has a square key and is inserted through the slot. The proper longitudinal location is assured by clamping the front end of the body slot against this key. In drilling the taper lock-screw hole, the work is located from the forward face of the slot by a transverse tongue.

An opening is next milled in the front wall of the body slot at the middle to receive the locating key, and this opening is then routed and chipped out. Holes are then drilled and tapped to receive screws for attaching the pilot strips to the bar, after which the bar is sent to a cylindrical grinding machine for grinding to the various diameters. Because of the length and comparatively small diameters of the bars, it is necessary to insure a good support for the work in this operation, and so four or five rests with adjustable jaws are spaced along the bar as shown in Fig. 7. After the bar itself has been finish-ground, the pilot strips are assembled and also ground to diameter.

The reamer bodies are next assembled and accurately adjusted by means of the locating key screws until the blades are central in the bar. For this step, the work is placed between the centers of a lathe equipped with an indicator, as shown in Fig. 8. The relation of the blades to the axis of the bar is determined by revolving them past the indicator. After this assembly, the blades are sent to the inspection department for a thorough checking before shipping.

A fixture of interesting design was constructed for holding rigid-bar tools at the necessary angle, as shown in Fig. 9, for drilling and tapping the holes for the blade adjusting screws. The work is held in the vee of a block that may be accurately swiveled to any angle by referring to graduations on the base and a scribed line on the block. A clamping screw is then tightened to hold the V-block in this setting.

* * *

SOLDERING FIXTURE FOR RADIO WORK

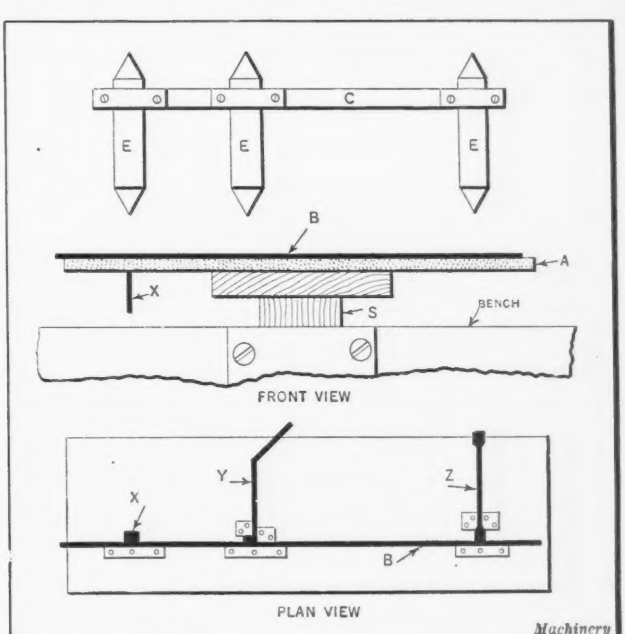
By DONALD A. HAMPSON

The eight-week courses in automotive electricity given at the Chicago plant of the American Bureau of Engineering, have recently been supplemented by a course in radio work. An attractive feature of the radio course is the experience gained in the manufacture of sets, which has been undertaken as a commercial enterprise in connection with the instruction. These sets offer some distinctive possibilities in receiving and have found a ready market. The coils, tubes, and some minor parts are bought from jobbers, so that the work consists of a limited amount of winding, assembling, and testing. The testing is done either by an instructor after hours or by an advanced student who works with an instructor.

Soldering enters largely into the assembling operation, and as the daily production is about thirty sets, it has been found worth while to tool up for most of the soldering jobs as well as for the drilling. The soldering fixtures, which were devised by one of the radio course instructors, are worthy of notice. One of these is shown in the accompanying illustration. It consists of a wood plunger *S* made from a piece of 2 by 4 dressed stock which carries on its upper face an asbestos sheet or plate *A* upon which the work pieces are laid for soldering. Different plates are made for the various assemblies and issued in regular tool-room manner. On these plates the bars and the wires to be joined are located by blocks of asbestos pinned to the sheet *A*. The method of using these blocks to locate the parts to be assembled is shown by the typical lay-out in the plan view of the illustration. In this view, the parts *X*, *Y*, and *Z* are shown held in position for soldering to the bar *B*.

The parts to be assembled are tinned before being placed in the soldering fixture, so that it is merely necessary to apply the heat and solder to the joints. Solder wire having a resin flux is used. The heat is furnished by one or more electric irons arranged to touch all the joints simultaneously. The three irons *E*, shown in the illustration, are held to the bar *C* by clamps. Bar *C* is held in a rigid position at a given distance from the work-bench by supports (not shown in the illustration). In some instances, the joints to be soldered do not all lie in the same straight line, and in such cases special bars *C* are provided.

The work is brought into contact with the irons *E* by raising the plunger *S* by means of a foot-treadle. The contact is maintained until the work has become heated and the solder applied. The part shown at *X* is dropped through a hole in the plate so that it is in a vertical position when soldered to the bar *B*. On some of the assemblies the joints lie in different planes, adjustment for which is made by shifting the irons in their clamps. Blueprints are supplied with each fixture, which show exactly how to locate the parts. Equipment of the kind described not only produces work of a better quality and does it quicker, but also gives the student an idea of commercial practice.



Fixture for Use in soldering Radio Assemblies

DIES DESIGNED TO REDUCE OPERATIONS

By P. J. SCHNEIDER

Costs may often be reduced in press work by performing two or more operations in one die. In Fig. 1 is shown a brass contact part for electrical equipment, which is first blanked and pierced, as shown in the top view, and then bent and otherwise formed as shown at the bottom, and at *A*, Fig. 2. All bends and crimps are produced by one die, and as the blanking and piercing steps are also performed in one die, only two die sets are required. The material is 1/16 inch thick "half-hard" brass. The die equipment was designed and made by the American Tool & Mfg. Co., Urbana, Ohio.

The piercing and blanking die, Fig. 3, is of the ordinary progressive type, the stock being fed from right to left. Eight holes are punched in the portion of the strip at the right-hand end of the die by punches which descend into holes *B*, while at the same time the portion of the strip punched in the preceding stroke is blanked out as at *C*. The strip is located by finger *D* for each descent of the punch. After a strip has been fed through this die, it is turned over and fed through a second time; during the second feeding, the spaces blanked before occupy position *E* relative to the die opening *C*. There are two pins on the die-block for guiding the punch-holder.

The punch used in the second operation is of the built-up type, as illustrated at the left in Fig. 2; here the punch is shown at its lowest position in the die-block. During this operation, pin *F* raises the metal at point *f* on the part as shown at *A*; projection *G* on the punch forms recess *g* on the work; and steps *H* on the punch and die crimp and bend end *h* of the work. Before lugs *i* can be bent up, it is necessary to shear the metal a short distance on one side of the lugs. This shearing is accomplished by means of blades *I* in the die-block, as shown in the plan view.

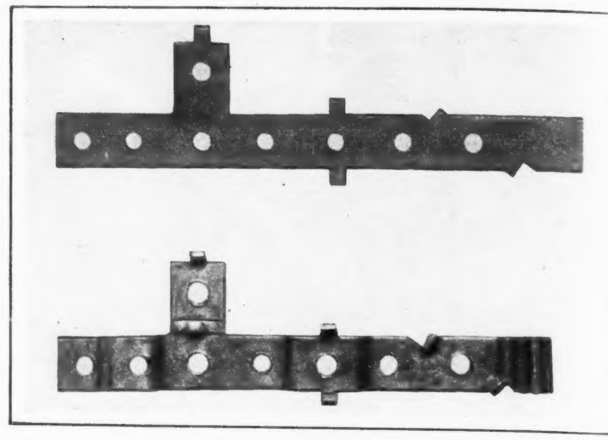


Fig. 1. Pierced Brass Blank and Finished Part

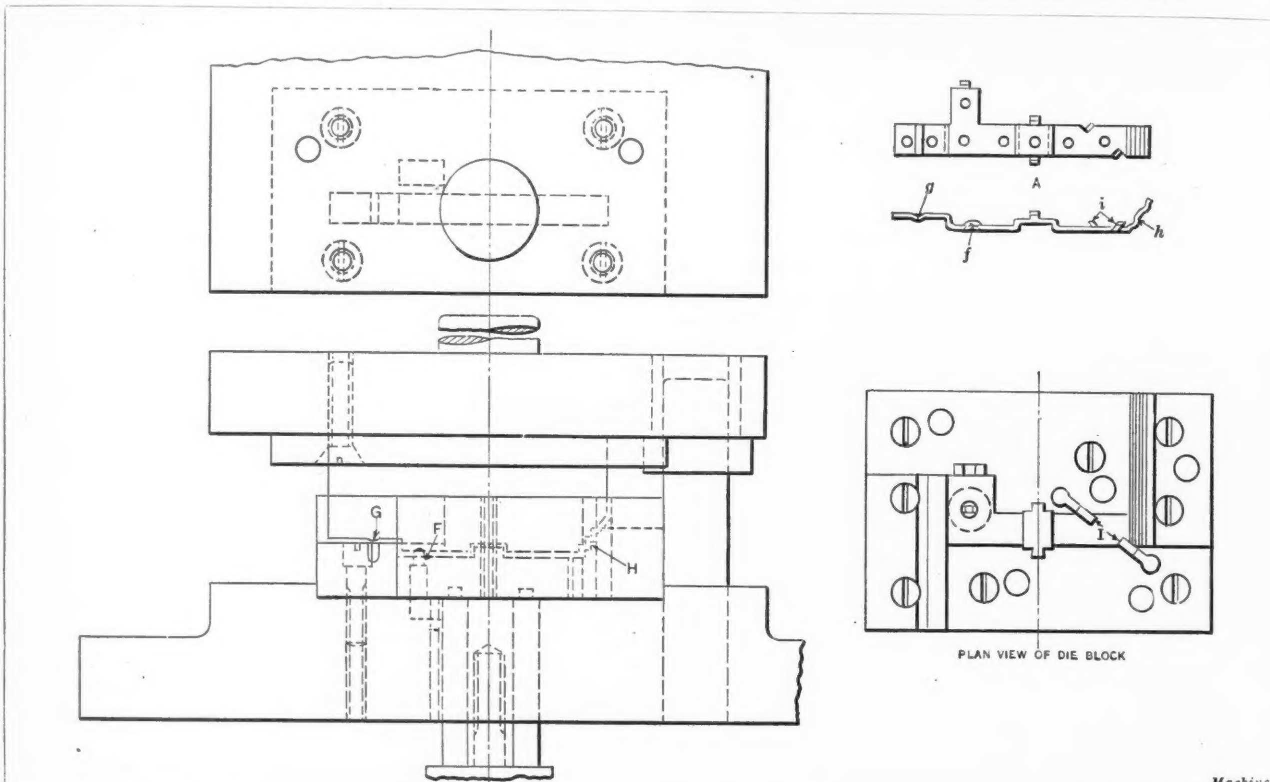


Fig. 2. Die Set used for crimping, bending, and otherwise forming the Piece shown in the Lower Part of Fig. 1

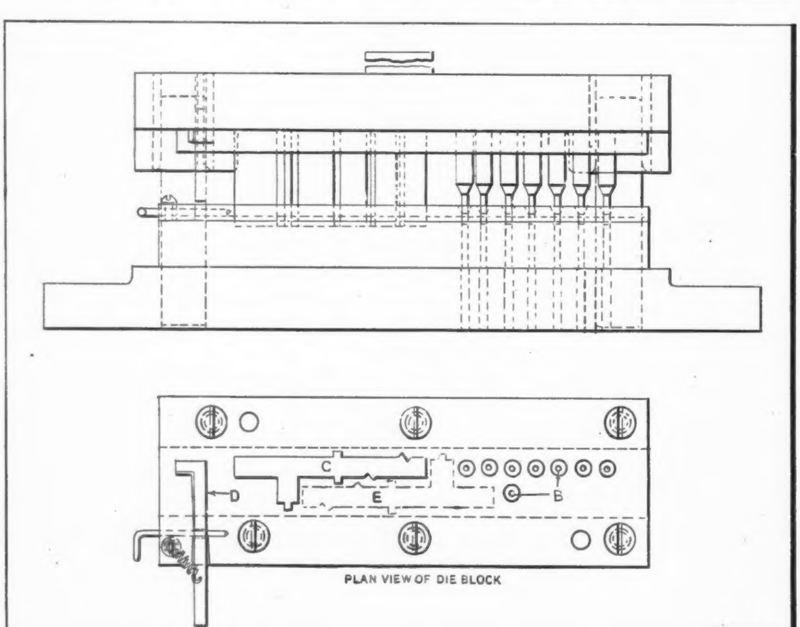


Fig. 3. Punch and Die used for piercing and blanking Part shown at the Top in Fig. 1

The British Metal-working Industries

From Machinery's Special Correspondent

London, February 14

IN several sections of the engineering industries, business in the new year has not come up to those expectations that would have been justified only by a distinct boom. Generally, however, a steady progress is to be noted. After three years or more of extremely bad conditions, prices, except in a few outstanding instances, have reached a level that verges on the uneconomic, and only a protracted and steady improvement can reinstate satisfactory conditions. The results of investigations made in all the important industrial centers indicate that this steady improvement is actually taking place, and a spirit of optimism is general. The few instances where prices are at an economic level are confined to products of well developed systems of manufacture.

The Machine Tool Industry

The outlook for the machine tool industry is becoming brighter. The Midlands area continues to be the most prominent in the output of machine tools. There is a gradual expansion of both home and export business, and only a very few works are not engaged at full capacity. A prominent builder of machine tools that are in demand for railway shops has orders in hand that will keep the plant busy night and day for the next ten to twelve months. In addition, a steady stream of new business is being booked, while both home and overseas inquiry is on a very liberal scale. Similar reports are given in connection with makers of machine tools used in the light and medium manufacturing trades.

In the drafting-rooms of Midland machine tool makers, it is now general to see a staff of a dozen or more in place of the two or three that were retained over the long period of slackness. The railway and automobile industries have been the first to appreciate the essential nature of the modern machine tool in meeting the present-day difficulties of high production costs, and in some quarters there is little hesitancy in making changes that show promise of manufacturing economy.

In the Yorkshire area, machine tool makers are looking forward to a much more prosperous year. The firms best employed are those engaged on the production of machine tools required on railway and bridge work, but machines specially built for a big output at low production cost are also in demand. In the Glasgow area, there is a strong inclination to wait until stability and permanence are more definitely assured before buying new equipment. Not many orders for machine tools have been placed in the last few weeks in this area, but the demand for small tools is good both for home and overseas.

Overseas Trade in Machine Tools

During December the value of exported machine tools was £127,330 for a tonnage of 1039. These figures represent a slight fall from those of November, but the general level is maintained. The value per ton of exports was £123, as compared with £126 for November. For the whole twelve months of last year the total value of exported machine tools was 46 per cent above the pre-war yearly average, but the corresponding tonnage was 22 per cent lower. A conspicuous feature of 1924 that was not in evidence during 1922 or 1923 was the steadiness of the export trade throughout the year, and the sudden spurts and depressions have given way to conditions that are represented by a much flatter curve. Imports in December rose, the value being £54,616, as compared with £37,726 for November.

General Engineering Field

Generally, the engineering industry started the new year with good prospects, and the first few weeks of the year have helped to increase these expectations. Firms that supply products to the building and constructional sections have perhaps the most promising outlook, as it is clear that the authorities are determined to catch up the leeway in the building of small houses. If some of the proposed schemes for steel and cast-iron houses prove as satisfactory as they promise, the engineering industry should reap a harvest.

Textile machinery makers started the year with fairly good orders. The increased import duties and the rates of exchange on the Continent, are, however, serious obstacles in the way of obtaining orders in competition with foreign makers. Orders for some time have been spasmodic, partly due to new textile developments taking place in various parts of the world, and in a considerable measure to the periodic prosperity of the home textile trade. The after-war replacements on the Continent have been completed, and the regular normal demands from this source are at present much below pre-war level. The building and extension of mills in Australia and India have brought in good orders. As indicative of the optimism prevailing in this branch of industry, it is noted that some of the textile machinery firms have been expanding during recent months.

Electrical engineering concerns are busy, and there are prospects of a better balance between the light and heavy departments. For some time, the heavy electrical departments have been extremely busy, but on the lighter sections, conditions have been slack. Small industrial motors find an improving market, while the rapid extension of electric lighting and the phenomenal demand for wireless equipment are some of the chief factors in the general improvement in the lighter sections of the electrical industry.

Although orders for locomotives continue to come through in twos and threes, this phase of engineering is not very satisfactory, and at present, a large percentage of the resources of the several finely equipped locomotive shops in the country is not being utilized. In structural engineering shops, the outlook is fair, but it is felt that too great a proportion of costs are eaten up in transport charges. These charges have a particularly bad effect on prospects of overseas orders.

Boiler-making firms are in a better position, and hydraulic engineers are well occupied. Several important new engineering works, power stations, and works extensions are to be erected this year, especially in the Lancashire area. Although the British Empire Exhibition is to be opened again this year at Wembley, the Palace of Engineering will not present the comprehensive survey of engineering products that was such an outstanding feature last year.

The Automobile Industry

The automobile industry continues to hold a unique position among engineering activities, and everything points to still further expansion. Night and day working is general, and plant reorganization and replacement is an almost continuous procedure. These remarks apply chiefly to light car production, but makers of high-priced cars and commercial vehicles are doing exceptionally well; manufacturers of commercial vehicles are at last showing a freedom of expansion now that war-time trucks have become practically extinct. Great Britain has at present over a million and a quarter automobiles on the roads, and is third only to America and Canada among the car-using countries.

Current Editorial Comment

in the Machine-building and Kindred Industries

REDUCING COST OF LABOR TURNOVER

Many employers fail to estimate the cost of losing a trained employe; but some of the larger industrial corporations who have investigated this subject, recognize labor turnover as one of the serious leaks in a manufacturing business. A representative of one of the largest manufacturing concerns in the country some time ago stated that the cost of training a new man to replace one who had either left of his own volition, or had been dismissed, averaged $35 for men holding the least responsible jobs, and ran as high as $500 for skilled men doing work for which they had been specially trained in the plant.

These figures indicate that a shop organization where there are few changes, other factors being the same, is likely to prove more productive than one where the labor turnover is greater. Some of the most successful manufacturers in the metal-working industries are noted for their ability to keep their employes, and no small proportion of their general success is doubtless due to the fact that they thereby avoid the waste incident to constant changes, and profit by the loyalty that always exists in plants where a large number of employes have a long record of service behind them.

Recently our attention was called to the long record of service of the men employed by a well-known manufacturing company, two of 50 or more years, 9 over 40 years, 24 over 30 years, and 149 over 20 years. The total number of employes is about 2000.

If the cost to our industries of labor turnover could be accurately computed, the amount would be so large as to make some of the savings that are now being made in other directions look small by comparison. All of the waste due to labor turnover cannot be prevented, but a large portion of it could be avoided by carefully selecting new employes in the first place, and by using greater care in retaining them after they have once been trained for their work.

* * *

SOMETIMES IDLE, BUT PROFITABLE

Everyone knows that the greater number of hours a machine is in operation during the year, the more profitable it is; but there are many executives who do not realize that machines which are idle a large part of the time may still be profitable to have around the shop. Too frequently we hear machines referred to as unprofitable investments because there is not work enough in the shop to keep them employed all the time. Yet these machines may have such labor-saving capacity that even if they are operated only one-third or one-half of the total working time, they may produce a satisfactory profit. Of course, they would produce a greater profit were it possible to obtain sufficient business to keep them running all the time.

Let us assume that an automatic machine costing $3000 is installed to do the work formerly done on four hand-operated machines requiring four operators. The productive capacity of the automatic machine is so great that it completes in six months the total annual requirements of the shop of the particular parts for which it is adapted. It stands idle six months in the year. It requires only one operator for six months, while the hand-operated machines call for the services of four operators for a whole year. The saving in wages in one year would be equivalent to, at least, the first cost of the automatic machine. Under these circumstances, the machine is not an unprofitable investment, even though it has to stand idle much of the time.

The idea that efficient machine shop equipment should not be bought because its productive capacity is so great that it may have to stand idle at times, does not conform to advanced practice. If this were true, our large farm tractor and other farm machinery plants would have to close their doors. Farm machinery is an extreme example of profitable equipment that stands idle during the better part of the year; some is used only for a month, or less than a month, each summer, but it saves enough labor in that brief period to make the investment profitable. Similarly, modern labor-saving machinery may be employed in machine shops to advantage, even though it may not be possible to keep it running throughout the entire year. Careful cost figures alone can show when it is profitable to buy a machine that sometimes must stand idle.

* * *

FROM SHOP TO DRAFTING-ROOM

The work of the draftsman has always appealed strongly to many young men whose mechanical training has been confined to the machine shop or tool-room. That shop training is of considerable value to the draftsman or designer is generally recognized; but it does not follow that the drafting-room is the best place for the ambitious mechanic. Much depends upon the individual. Some shop men are naturally proficient in working with their hands, in constructing what others have designed, and in operating machines and tools efficiently. Other shop men, either because of inherent ability or better school training, are more adept in solving problems and planning new devices than in doing construction work. Men of the first class had better stick to the shop and fit themselves for a position as foreman or superintendent. Those in the second group often advance more rapidly by studying mechanical drawing and machine design.

Before the shop man decides to leave the machine or bench for a drawing board, it is extremely important for him to ascertain what qualifications are required in a drafting-room. Unfortunately, many young mechanics seem to believe that mere drawing constitutes the work of the designing department, and the creative side of the designer's work is not clearly appreciated. As a general rule those graduating from the shop into the drafting-room should specialize in tool design, because designing tools, jigs, gages, etc., requires an intimate knowledge of shop practice. For that reason, the shop-trained man is often superior to the graduate of an engineering college, for tool designing; but in many other branches of designing work, the former would be seriously handicapped by lack of scientific knowledge.

* * *

THE RESULTS OF STANDARDIZATION

Briefly stated, standardization simplifies the work of the designer and assures the use of parts that are designed in accordance with successful engineering practice. In the manufacturing departments, standardization limits the number of sizes to the minimum and reduces production costs, because of the longer production runs, the reduced tool costs, and the reduced overhead per piece. Standardization cuts down inventories and increases sources of supplies. Machinery and equipment are "out of service" less than under the old methods, the work of the service department is simplified, the stock of repair parts is reduced, and replacement parts are obtained more quickly. There is no doubt but that it "pays to standardize."

Selling New Types of Machine Tools

By GEORGE M. MEYNCKE, Sales Manager, Oesterlein Machine Co., Cincinnati, Ohio

THE operation of standard machine tools, such as regular engine lathes, shapers, or drilling machines, needs no explanation to the production man, nor are the fundamental principles of their application foreign to other officials in the user's plant with whom the machine tool salesman comes in contact. To the purchasing agent and other members of the office staff of an organization, a lathe is a lathe, and a shaper a shaper; but many of the specialized automatic and semi-automatic machines recently placed on the market have names that do not impart any idea of their fundamental operation. This is particularly true of a number of recently brought out automatic machines, the names of which are formed with the suffix "matic."

The salesman ordinarily deals only with the production man, but there are times when other officials must also be consulted, and he should be able to point out to them briefly the advantages of the machine, and also explain the reasons for these advantages. Failure to be able to do this often delays the placing of orders, and a thorough salesman, therefore, equips himself with suitable material to meet the needs of those men who are partially, as well as those who are thoroughly, informed about the mechanical processes involved.

When standard and conventional types of machines comprise his entire line, his work is not so difficult as when he has to introduce new types of machines, the functions of which are not generally known or the operation of which is not generally understood.

The production engineers, superintendents, foremen, master mechanics, and tool supervisors, who are either partially or wholly responsible for the selection of machine tools, are of two general types. Some have risen to their present positions from the engineering departments, while others have had very little engineering experience, having come to their present positions from the shop side of the business. Both of these types of men are "eye minded," that is, they respond mentally to what they see, rather than to what they hear.

An ideal way of conveying an idea to an engineer is to place a blueprint or a sketch before him. The shop executive does not depend upon mechanical drawings as extensively as the engineer, but he also gains his impressions largely from the eye. The characteristics of executives are a quick inspection, and rapidly and tenaciously held ideas. To convey information by talking is usually too slow and precarious a method for the salesman; it is better to hand the executive a photograph or a leaflet.

The rapid increase of new types of machine tools, however, gives the salesman quite a problem in introducing these tools, even though he has access to ordinary blueprints and photographs. The production man is a level-headed person who refuses to consider any machine until he understands the theory of operation around which the machine is built. The salesman may tell him thus and so, but the production man wants to know the "how and why" that is responsible for its production.

Erroneous First Impressions Must be Prevented

There is ever present the danger of a lack of appreciation of new types of machines, because of the tendency of the production man to jump at conclusions. These "eye-minded" men glance at the drawing of a machine and too rapidly form their own opinions of its operation and its application to their work. Should these hastily formed ideas be incorrect, it is very difficult to change them. It is necessary to remove the first impression in order to build up a new and entirely different one. The fact that production men are "eye-minded" may be turned to advantage and utilized in the preparation of sales material that pictures the story the salesman has to tell so vividly that one look and a few words are all that are necessary.

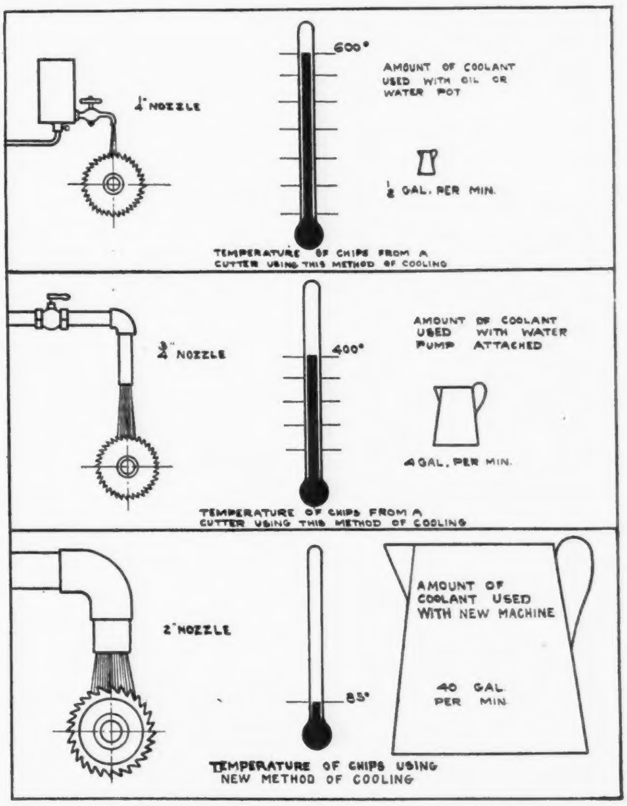


Fig. 1. Graphical Method of presenting to a Prospective Purchaser the Amount of Cooling Compound supplied by Different Methods and the Effect in cooling the Cutter and Work

Best Way of Presenting Facts is by Simple Drawings

To present data by means of curves is one means of picturing information that would require a lengthy and involved description. The engineering type of mind is usually able to obtain the desired information from a curve, but the shop executive type is not nearly so proficient at reading curves. Fortunately, there are easier ways of presenting information than by the use of curves. The mechanical features of a machine can often be pictured by simple drawings.

An example of such a representation is given in Fig. 1, in which the volume of cutting coolant provided for a new type of machine is compared with the cooling ability of other types of machines built by the same manufacturer. The comparison of the respective volumes of coolant is represented by liquid measures of proportional size, and the effect on the chips and work is represented by thermometers. This comparison gives quickly a vivid mental picture to the executive, and is also satisfactory to the more analytical engineer.

Many designs and equipment features can be represented by drawings of this nature. This particular sketch was drawn for temporary use in the form of blueprints, with the intention of supplementing the blueprints with more attractive drawings that could be used in making zinc engravings so that the comparison could be printed in a cat-

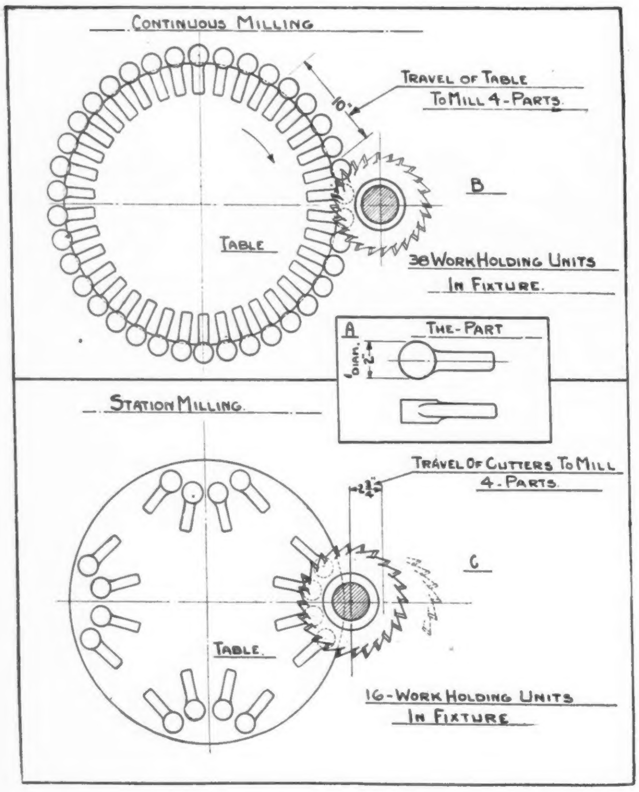


Fig. 2. Graphical Illustration used to show Difference between Continuous and Station Milling

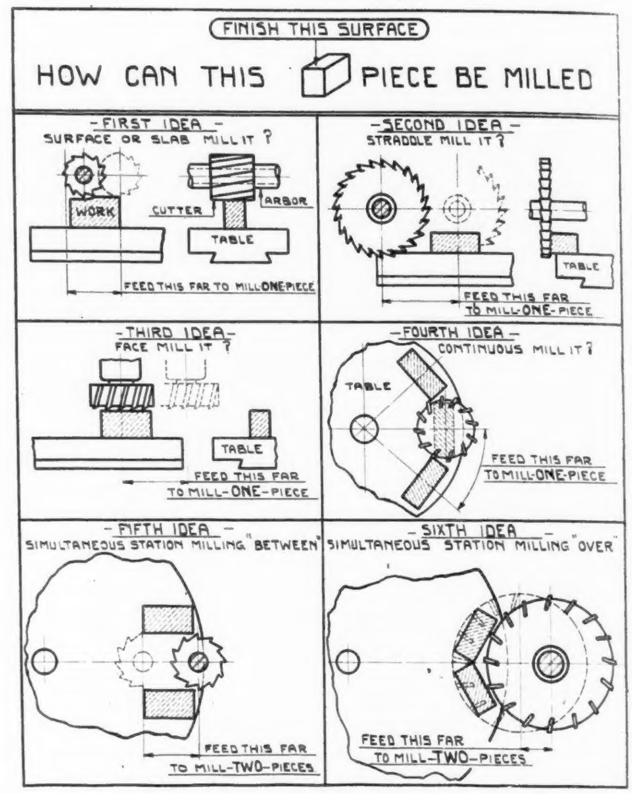


Fig. 3. Illustration that shows Various Methods of milling the Same Part

alogue. The use of the blueprints demonstrated their value among mechanics, and the requests for them became very numerous. In fact, it would have been cheaper, but less effective, to have resorted to printing from the start.

Introducing a Machine of Novel Type

A new type of machine that employs a different principle of operation from conventional designs of milling machines is built by the company with which the author is connected. The table of this machine is round, and the production man is likely to note the round table and jump at the conclusion that the machine is a continuous milling machine, because continuous milling is a method with which the production man is familiar and it is associated with round tables. The problem in this case is further complicated, because the hastily formed opinion is partially correct. The machine can be used as a continuous milling machine, but it is best and most generally used as an automatic station milling machine. In order to combat first-sight conclusions, it was necessary to adapt a certain method of presentation for instilling into the mind of the prospective purchaser the fundamental principles of station milling.

The salesmen, therefore, developed the habit of opening their explanation by saying, "This is not a continuous milling machine for the reason . . ." and then proceeded to show in blueprint form (Fig. 2) the comparison between the continuous and station milling machines. The arrangement of work on the table, the differences in length of cutter travel to mill four parts, and the number of work-holding units required for each method are

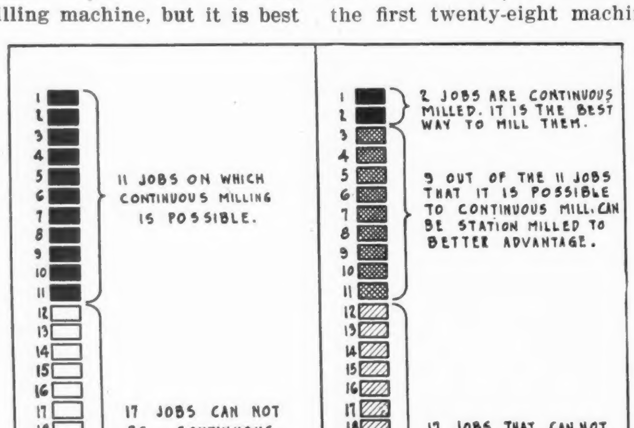


Fig. 4. Graphical Illustration used to analyze the Uses of Continuous and Station Milling Equipment

pictured. After the idea of station milling is firmly implanted, the salesman states that the machine may also be used as a continuous milling machine, if desired.

The Man Whose Problem is an Exception

It is only human nature for an individual to regard himself or his case as an exception, and production men are just as human as the rest of us. They relinquish reluctantly the thought that the methods they have used in the past can be surpassed. They frequently admit that in other shops new methods are applicable, but they regard their own case as different. This is mental inertia and sales resistance, but should not be considered stubbornness. The impression that their own case is a special one must be gradually deleted. A graphic representation, such as that shown in Fig. 4, represents an analysis of the jobs for which the first twenty-eight machines built are used. This idea can be applied to many similar sales problems.

Educational Work of Salesman

The preliminary work of introducing a new machine tool is educational in character. The machine tool salesman is an instructor, and every teacher knows that for effectiveness he must be equipped with several ways of saying the same thing. The first explanation leaves an impression, the second instills a general idea, and it frequently requires a third or fourth in order that the full force of an idea be firmly implanted. A change of pictures is often of assistance in rehashing the same idea. Fig. 5 differs from Fig. 2 only in that station milling is compared to an actual job on a straight-feed table in

order to show the relation between the number of cutters used and the production rates. Fig. 3 shows the various methods of milling an identical part in order to show the difference in cutter travel per part produced.

In using comparison of methods, there is one important point to bear in mind, and that is to stay within the products of your own manufacture. In the examples shown, the manufacturer builds every type of machine with which com-

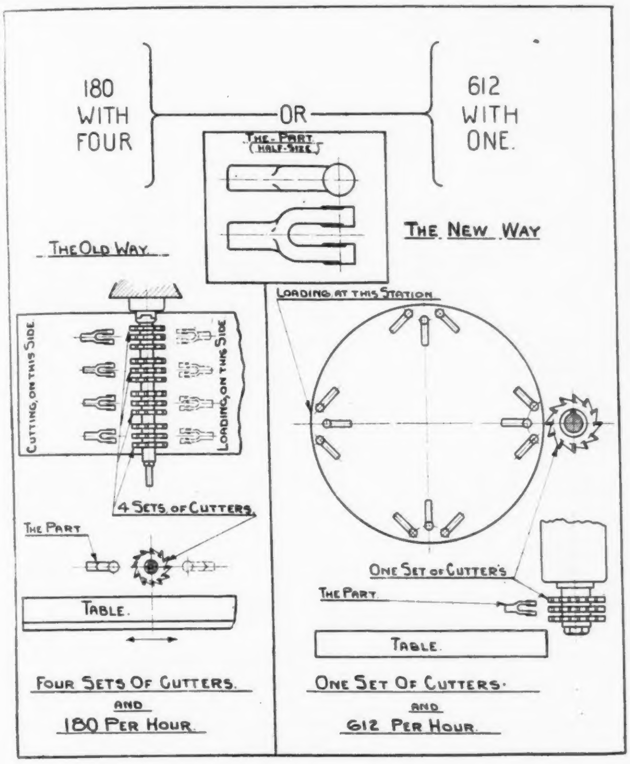


Fig. 5. Comparison between Different Methods of Milling

parison is made, and these machines use every method that he employs in making his comparisons. He is merely comparing his various methods to show their relative value when applied to a certain job, certain quantities, and certain shop conditions. To compare your machine with another maker's products in this way is not clean-cut business. Even though it may not be illegal, it is certainly very poor salesmanship.

* * *

CUT AND DRAW DIE FOR GASKET RING

By F. MARTINDELL

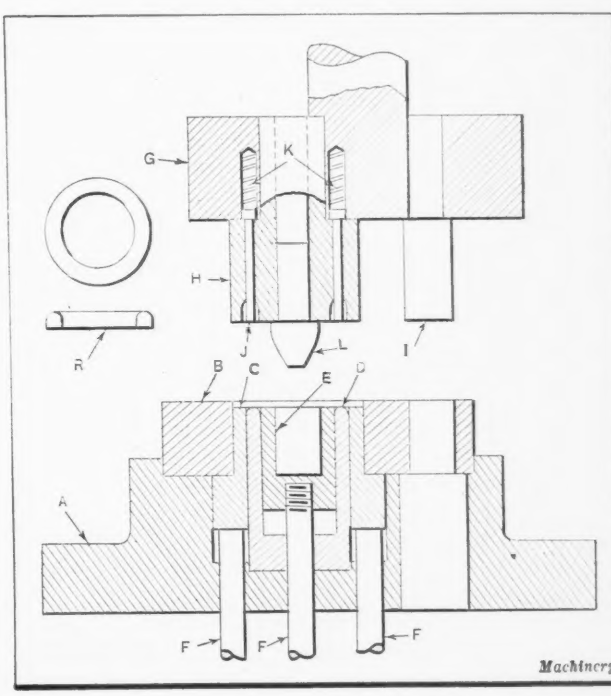
While the use of combination cut and draw dies for the production of shallow metal shells is well known, the application of this method of production to more complicated shapes is not so common as it might be. The accompanying illustration shows a cut and draw punch and die used for the production of a gasket ring *R* for a combination zinc and cork gasket. This gasket consists of a ring of thin sheet zinc into which is forced, in a later operation, a ring of compressed cork. Our present interest is in the die illustrated, which produces the zinc ring in one operation from sheet stock.

The die consists of the following parts: The die-holder *A*; the cutting die *B*, which is screwed and doweled to the top of block *A*; the upper stripper ring *C*, which slides freely in a recess in block *A*; the drawing ring *D*, which is screwed to *A*; the inner stripper ring *E*, which slides freely in drawing ring *D*; and the push-rods *F*, which bear against the usual spring and plate below the bolster of the press. The top of the die is covered by a stripper plate (not shown). The punch consists of the punch body *G*, the large cutting and forming punch *H*, the small piercing punch *I*, four stripper-pins *J*, stripper-pin springs *K*, and the pilot *L*, set in the punch *H*.

When the die is in operation, the stock is fed under the stripper by the roll feed of the press, and the punch *I* pierces the central opening of what is later to be the ring that forms the gasket shell. On the next stroke of the press the pilot *L* enters the hole pierced by punch *I* and locates the stock for the cutting punch *H*. After punch *H* has cut the ring for the shell, it carries it down, still guided by pilot *L*, until the ring is grasped between the face of punch *H* and the outer and inner pressure rings *C* and *E*. As the press ram continues downward, the pressure rings *C* and *E* are carried down by the action of the punch, and the stock is drawn over the forming ring *D*, the pressure of rings *C* and *E* preventing wrinkling. On the return stroke of the press, rings *C* and *E* strip the shell from the forming ring *D*, while the stripper pins *J* prevent the shell from sticking in the recess of the forming punch *H*. It is necessary to use the stripper pins *J*, because since the shell surrounds the central portion of punch *H*, there must be some positive means of ejecting it from the groove.

In setting up this set of tools, it was found necessary to adjust the inner pressure ring *E* a little tighter than the outer pressure ring *C*, as the smaller surface of the inner ring allowed the stock to be drawn from under it more readily, which resulted in the inner edge of the shell being lower than the outer edge. This could have been avoided by finding the blank diameter experimentally, but as the job was one on which a very short time for making the tools had been allowed, it was necessary to compute the diameters of the blank and make up the tools without stopping to find the diameter by the usual methods.

Three sets of these tools were made for gaskets having inside diameters of 3/4, 1 1/2, and 2 inches respectively, all of which were entirely satisfactory in operation. Owing to the fact that the stock was 0.012 inch soft zinc, the punch *H* was left unhardened, and was sharpened when necessary by



Die for blanking and drawing Gasket Rings

peening out the outer edge and shaving it into the die *B*. The inner radius of the edges of the recess in the punch *H* were rounded to a radius of 1/32 inch, to prevent tearing the stock in drawing.

* * *

The production of raw materials, as measured by the Department of Commerce index for 51 commodities relative to 1919 as 100, equaled 142 in December, the last month for which complete returns are available. The index for manufacturing production, based on 64 commodities, stood at 110; and for commodity stocks, based on 45 commodities, 144.

Questions and Answers

VALUE OF GRINDING WHEELS USED IN AUTOMOTIVE INDUSTRY

F. V.—Are there any statistics showing the value of grinding wheels used annually in the automotive industry?

A.—No complete statistics are available showing the value of grinding wheels used in the automotive industry. It is possible, however, to arrive at an approximate figure by using as a basis the value of grinding wheels used in certain automobile plants. One automobile manufacturer building a large, high-grade car uses grinding wheels to the value of four dollars for each car built. Another manufacturer building one of the least expensive cars on the market uses grinding wheels to a value of slightly over one dollar per car. From these two figures it would seem reasonable to assume that the average wheel cost per automobile built, considering both the cheaper and the higher grade cars, would run about two dollars per car, and this would indicate a wheel cost in the entire automotive industry for 1924, when 3,500,000 cars and trucks were built, of approximately $7,000,000.

It may be of interest in this connection to note that the cost of diamonds for wheel dressing in the plant building the high-grade car referred to, is 56 cents per car, while in the plant building the cheaper car, it is 27 cents per car. It pays to use a good grade of industrial diamonds, although it is often practicable to use what are known as "slivers."

PAINT THAT INDICATES TEMPERATURE OF BEARING

A. R. W.—The writer has been told that there is a paint made by a firm in Germany, which, when applied to the outer surface of a bearing housing will indicate overheating by a change in color. Can you give me any information regarding this?

A.—A light red paint of German origin, which can be applied to any machine member that is likely to run hot and which shows immediately if the part is beginning to heat by a change of color, is known by the trade name "Efkalin." The normal color of the paint is light red, but at a temperature of 122 degrees F. it becomes dark red, and at 158 degrees F. the color changes to a brownish red; at temperatures exceeding 185 degrees F. the color becomes nearly black. An important feature of this paint is that it returns to a normal light red color when the temperature of the part has dropped back to the normal point.

COLD-DRAWN BARS

O. A. B.—In the plant where the writer is employed there seems to be some confusion in the application of the terms "cold-drawn" and "cold-rolled" stock. Will you kindly explain just what is meant by the two terms?

A.—Cold-drawn bar stock is frequently but erroneously referred to as cold-rolled, whereas the term "cold-rolled," if properly used, refers to sheet steel that has been finished by cold-rolling. Cold-drawn stock, in round, square, or hexagonal bars, is cold-drawn in order to improve the physical properties of the surface, to produce bars of very accurate dimensions, and to obtain very smooth and even surfaces. In making cold-drawn stock, ordinary rolled bars are first pickled in order to remove the scale. They are then cold-drawn through dies and straightened by being passed through revolving straightening machines known as "flyers." The result of the latter operation differs for open-hearth steel bars and Bessemer bars. The former are increased slightly in diameter, this phenomenon being known as "swelling," while the latter are reduced in diameter due to "shrinking." The reduction obtained when cold-drawing is slight, because a great deal more power is required to reduce the diameter in this manner than by hot-rolling. For this reason the cost of cold-drawn stock is much greater than that of hot-rolled stock. Cold-drawing may increase the tensile strength from 20 to 40 per cent and the elastic limit from 60 to 100 per cent, but it reduces the elongation.

TEMPERATURE FOR GAGE STANDARDIZATION

W. S. J.—Inasmuch as the length of a gage varies somewhat with temperature changes, it is evident that the length should be based upon some standard temperature. What is this standard temperature in the United States, and is the same temperature employed in other countries for industrial gage and instrument calibration?

A.—In the standardization of precision gages for industrial use, 68 degrees F. has been adopted generally in the United States during recent years as the standard temperature, because it is the common or average working temperature to which gages are ordinarily subjected in practice. Formerly 62 degrees F. was the temperature used for precision gage standardization, as this is the temperature, approximately, at which the standard yard bar is at the correct length. While 62 degrees F. still applies, of course, to the fundamental standard yard bar in Washington, a temperature of 68 degrees F. is the generally used working standard for the calibration of industrial gages.

This temperature not only conforms to average working temperatures, but it has been widely employed for many other physical tests, and moreover, it is the exact equivalent of 20 degrees C. This same temperature of 20 degrees C., or 68 degrees F., has been adopted as the standard for gage work and other industrial measuring instruments, by engineering standardization bodies in Germany, Holland, Sweden, and Switzerland. In Great Britain the temperature of 62 degrees F., which applies to the fundamental standard yard bar, is also employed as the basis for industrial gage and instrument calibration.

Two temperatures—0 degrees C. (32 degrees F.) and 20 degrees F. (68 degrees F.)—are employed for the industrial standardization of metric measuring instruments. The 0 degrees C. temperature is the standard at which the fundamental standard meter bar is of correct length, but as this temperature is far below ordinary working temperatures, materials having different coefficients of expansion would show measurable differences in length when the temperatures were increased from 0 degrees C. to ordinary working temperatures. For this reason the director of the International Bureau of Weights and Measures recommended the following practice, which, incidentally, has been very generally adopted in France: Gages and other measuring instruments used in the manufacture of metal parts should be so made that when calibrated at a temperature of 20 degrees C., they will have an assumed coefficient of expansion of eleven millionths per unit of length per degree centigrade. In other words, at 20 degrees C. the actual length of such standards will be 220 millionths per unit of length longer than the corresponding subdivision of the fundamental standard of the meter at 0 degrees C. This assumed coefficient of eleven millionths is approximately correct for steel and cast iron, and the error due to the difference between this arbitrary coefficient and the actual coefficient of ordinary gage materials is so small that it may safely be ignored in industrial gage standardization.

PRODUCING FLAT BRASS BLANKS

N. H.—We have found some difficulty in obtaining absolute flatness in half-hard, practically semicircular, brass plates measuring 3½ inches by 2 inches by 0.020 inch thick. The brass comes in long flat strips, 3⅝ inches wide, out of which these blanks are stamped. Is there any practical method of embossing or pressing the surface to obtain absolute flatness? The plates as they come out of the press are wavy and distorted.

ANSWERED BY JACOB H. SMIT, NEWARK, N. J.

In order to take the wave out of the blanks, they should first be bent and then straightened again with a die having a surface that is slightly concave. The distortion of thin blanks is sometimes caused by insufficient clearance in the die, or if there are pierced holes in the blanks, the pilots may fit the holes too tightly or not line up properly.

In cases where the die has already been made and a small increase in the size of the blanks will not matter, the punch can be rounded slightly by grinding. If this cannot be done, two operations will be required, namely, a bending and a straightening operation. If the blank is held between a pressure pad and a knock-out or spring-backed pad, as in a compound die, better results will be obtained also.

RESHARPENING FILES

K. B.—Can any reader of MACHINERY tell me how to resharpen files with acid solution?

ANSWERED BY A. EYLES, MANCHESTER, ENGLAND

There are several processes for resharpening files by the use of acid solutions. A number of patents have been filed covering certain methods of resharpening files by such means, but most of these patents have expired. The writer has tested files sharpened by etching with acid solutions, and in most cases has found that they gave very good results. Of course, the acid must not be permitted to attack the files unduly. To prevent this, it is advisable to make a few tests or trials to determine the length of time the files should be immersed in order to obtain the desired results, before proceeding with the work on a quantity basis. The methods outlined in the following paragraphs are among those most generally employed.

1. First clean the files by immersing them in a solution of caustic soda and boiling water for a period of from ten to fifteen minutes. This solution is made by dissolving 100 grains of caustic soda in one gallon of water. The same proportions should be used if a larger quantity of the solution is required. Two gallons will ordinarily be sufficient for cleaning 100 files of the sizes generally employed in the shop.

After the cleansing treatment, the files are placed in an acid bath. This bath is made by adding twelve parts of water (by volume) to a solution consisting of one part nitric acid, one part fuming (Nordhausen) sulphuric acid, and one-third part concentrated sulphuric acid. These parts are measured by volume and not by weight. The files, when placed in the acid solution, should not overlap and should be arranged so that the solution will reach all surfaces. It is preferable first to suspend the files in the tank and then add the acid solution. The files should be allowed to remain in the solution from five to ten minutes, the exact time being determined by experiment.

2. Another process consists of immersing the files in a warm aqueous solution of nitric acid and hydrochloric acid, consisting preferably of about equal parts of the acids and of water. This solution should be kept at a constant temperature. After the files have been treated with the acid solution, they should be washed in lime water or some other alkaline solution, and then wiped with oil.

3. A third method is to submerge the files in a solution consisting of one quart of nitric acid, one pint of hydrochloric acid, and two gallons of water. In order to prevent the files from rusting when treated in this solution, they must be transferred quickly to a strong solution of caustic soda, rinsed thoroughly, dried quickly, and wiped with oil.

4. A process in which an electric current is employed requires the files to be first cleaned by nitric acid solution. Following this, chalk is rubbed into the file teeth grooves, and the files are immersed in a copper sulphate solution until a film of copper is deposited on the crests of the teeth. The files are next immersed in a dilute solution of mercurious nitrate, which gives the copper a mercury coating. Resharpening is effected by employing an electric current in connection with a dilute solution of nitric or hydrochloric acid. The crests of the file teeth subjected to this treatment, being protected by the mercury coating, are not acted upon.

5. Another method sometimes employed is similar in some respects to the electroplating process, except that the files serve as the anode and the tank lining as the cathode, the current flowing from instead of to the files. The lining of the tank is sheet lead, the bottom being covered with an insulating material to reduce the area of the exposed surface of the cathode. The negative terminal of the dynamo used for plating is connected to the lead lining of the tank, and a brass bar extending across the receptacle and insulated from it is connected to the positive terminal of the dynamo. The acid solution employed is composed of sulphuric acid and water in the proportion of one part acid to five parts water. The current used ranges from three to five volts and the time required for the operation is about thirty minutes.

The files are suspended vertically from the brass anode bar by means of wire clips, so arranged that the files are submerged in the acid up to the base of the tang. Of course, the files must be free from oil or grease before they are immersed in the acid solution. In order to remove all grease or oil, the files are boiled in a strong solution of caustic soda and then subjected to a thorough washing in hot water to make certain that no alkali remains on them before they are suspended in the tank.

In order to prevent the files from rusting after they have been resharpened, they are thoroughly rinsed in clear running water and then suspended in boiling water containing a small amount of sal soda. They are left in this tank until they are heated through, after which they are removed and allowed to dry. A protective coating is finally given the files by rubbing them with an oil cloth.

ANSWERED BY A. N. CLARK, CHARLOTTE, MICH.

The writer's experience in sharpening between 2000 and 3000 files in acid solutions has led him to select the following method as the one giving the best results. The first step is to remove all grease and dirt from the files. This may be done by soaking the files a few hours in gasoline and then brushing them with a wire brush, or by boiling them a few minutes in a 10 or 15 per cent water solution of caustic soda and then drying and brushing them. It is essential that the files be thoroughly cleaned, as the acid cannot reach the steel through grease or oil.

The clean files are placed in an enamel basin, a lead lined box, or a "Pyrex" glass baking dish. Short pieces of wire or nails are placed between the files to separate them sufficiently to permit the acid to reach all the surfaces that are to be sharpened. After covering the files with water, sulphuric acid is slowly poured into the tank until a solution that is about 25 per cent acid is obtained. As the acid combines with the water a considerable amount of heat is generated which causes the acid to act more rapidly. Files having fine teeth may be sharpened in from three to five minutes, while files with coarse teeth generally require from five to twenty minutes. A second batch of files can be treated in the same solution by adding a little sulphuric acid. After two or three batches of files have been treated, however, it is usually necessary to either heat the solution or make a new one.

Caution must be exercised when mixing sulphuric acid and water. Always pour the acid into the water slowly; never pour water on the acid, as an explosion may result,

the same as when babbitt is poured into a wet box or mold. In both cases the explosion is caused by the sudden generation of steam. Commercial hydrochloric acid diluted with about 10 per cent water and heated to near the boiling point can be used instead of sulphuric acid solution. The diluted hydrochloric acid has the advantage of being safer to handle. The writer would not advise the use of nitric acid for three reasons. Nitric acid costs more than sulphuric acid, it gives off disagreeable poisonous vapors, and it stains and burns the operator. As soon as the files are removed from the acid solution, they are washed in running water and dried rapidly by heating. After drying, they may be dipped in gasoline containing about 5 per cent paraffin or engine oil. The gasoline evaporates, leaving a thin coat of oil on the files.

COATINGS FOR BABBITTING MANDRELS

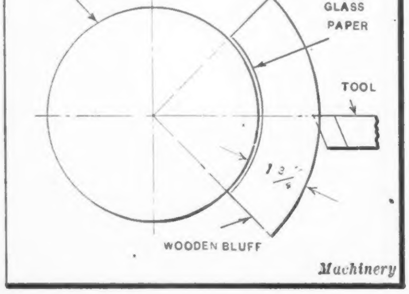
M. R. D.—In babbitting some small solid bearings, we have been using a very thin coating of light oil on the mandrel to facilitate removing it from the bearing. In some cases the surface of the babbitt that is in contact with the mandrel appears to be blistered. Is this blistering caused by the oil, and if so, what substance can be used in place of oil?

A.—Oil on the surface of a mandrel tends to cause the babbitt to blister, and for this reason it is preferable to use some other means to facilitate the removal of the mandrel from the bearing. One method is to hold the mandrel in the smoke from an oil flame which will coat the surface with carbon. Instead of smoking the mandrel, the surface is sometimes covered with a coat of thin white lead. Another method is to wrap a piece of paper about the mandrel. In order to avoid blow-holes and defects in babbitt linings, it is the practice of a large electrical concern to cover the mandrels with a thin coating of clay wash by plunging them, while heated, into a pail containing a solution of one or two pounds of Jersey red clay. When the mandrel is dry, the thin clay coating prevents the formation of blow-holes and the babbitt lining will have a smooth surface.

MACHINING COMMUTATORS

H. R. S.—What tools and speeds are generally used in machining and finishing commutators?

A.—Commutators, which are principally of copper, are generally turned with a pointed tool. Light cuts should be taken at a peripheral or surface speed of about 200 feet per minute. After being turned, the commutator is finished with a wooden buff lined with glass paper, as indicated in the accompanying diagram. The buff is in the form of a 90-degree segment and is approximately 1¾ inches thick. It is held against the commutator with the point of an ordinary tool and is fed back and forth across the surface. This finishing operation is continued until the segments are gradually ground down so that there is not the slightest gap or break between the copper segments and the mica insulation.



Method of finishing Commutator

SKIN BREAKAGE

H. R. E.—Please explain what is meant by the term "skin breakage" as applied to cold-drawn bars.

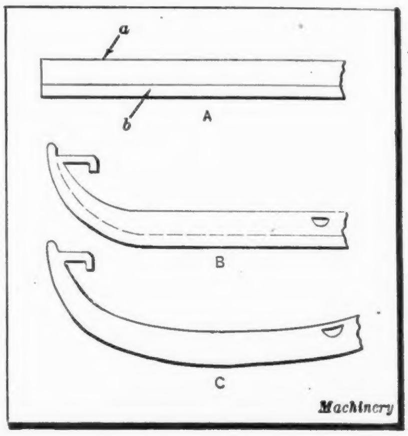
A.—In cold-drawing bars larger than 3 inches in diameter, breakage sometimes occurs if too heavy a reduction is attempted without properly annealing the bars. In the larger sized bars, cold-drawing produces a skin or shell on the surface, and when breakage occurs, it sometimes happens that this shell only is broken, a condition which is known as "skin breakage" or "shelling."

STRAIGHTENING PAPER CUTTING KNIVES

D. M.—I would appreciate information as to how to straighten paper cutting knives after heat-treatment. These knives are made from machine steel, 1⅝ by 2 by 36 inches. To this is welded a tool-steel edge of Swedish steel, ¼ by ⅝ inch. In the heat-treatment of these knives, they bend out of shape, being concave on the flat surface and convex on the tool-steel edge. After straightening, the tool-steel edge is ground to a knife edge. If any reader of MACHINERY has had actual experience with work of this kind, will he kindly indicate how he straightened these knives successfully?

ANSWERED BY JACOB H. SMIT, NEWARK, N. J.

When high-carbon steel is welded to low-carbon or machine steel, the piece thus formed will often be bent or distorted when the carbon steel piece is hardened. The writer's first experience with trouble of this kind was in the manufacture of skates. The skates were made by welding a piece of ⅛- by ⅜-inch tool steel to a piece of ⅜- by ⅜-inch machine steel and hammering out the combined pieces until they were about 3/16 inch thick by ⅝ inch wide. Referring to the accompanying illustration, the pieces welded together are shown at *A*, the machine steel being indicated at *a* and the tool steel at *b*. After the forging or hammering operation, the piece appeared as at *B*.



Skate Blade in Various Stages of Completion

When the piece was hardened, it would invariably be bent as indicated in view *C*. After drawing the distorted or bent piece to a light straw color, it was peened with a light-weight hammer until straight. While straightening the skate runners, it occurred to the writer that bending the pieces in the opposite direction before hardening might eliminate the necessity for the final straightening operation, or at least lessen the amount of peening required.

The paper knives should be handled in the same manner as the skate blades. First the amount of distortion produced by hardening should be determined. The knives can then be bent in the opposite direction to counteract the warping or bending produced by hardening. If a knife or blade is not entirely straight, the tool-steel side can be placed in contact with the anvil, after tempering or drawing, and the iron side pounded or peened while the metal is still warm. A medium-weight peening hammer should be used for this operation, and care should be taken to see that the knife bears on the anvil at a point directly beneath that struck by the hammer. Clamping the knife or blade between two pieces of iron of suitable thickness, and allowing the edge to project from the iron pieces, preparatory to quenching the work, will help to keep the blade straight.

* * *

The Gage Steel Committee of the Bureau of Standards has issued its Twelfth Progress Report, dealing with stress generation in hardened tool steel and wear test results. This report may be obtained by addressing H. W. Bearce, secretary, Gage Steel Committee, Bureau of Standards, Washington, D. C.

Fig. 1. Graphite Flakes in Cast Iron; Magnification, 100 Diameters

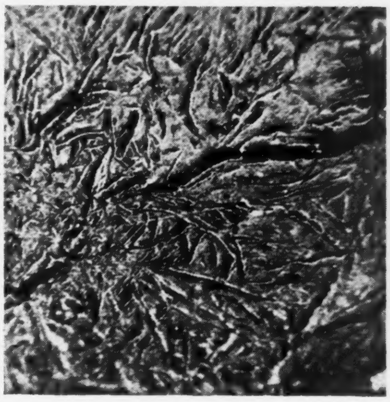


Fig. 2. Fracture in Cast Iron; Magnification, 20 Diameters

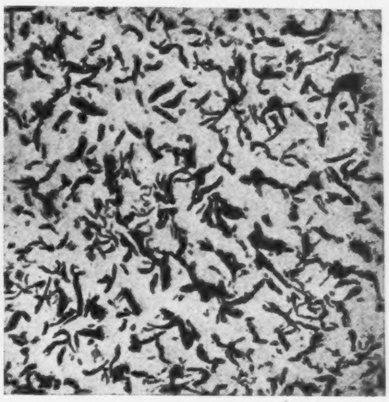


Fig. 3. High-strength Semi-steel; Magnification, 50 Diameters

Factors Influencing the Machineability of Cast Iron

By JOHN W. BOLTON, Metallurgist, The Niles Tool Works, Hamilton, Ohio

IN cutting cast iron and semi-steel, the metal usually breaks off or is pushed off in advance of the tool, whereas in cutting steel it is torn off. Failure of the tool in cutting cast iron often seems to be due to some gritty material in the iron. Indeed Taylor in "The Art of Cutting Metals" states, "It is also probable that cast iron, containing more carbon in the form of gritty graphite, which is combined in a very hard state, is more abrasive in its action on the tool. All these conditions tend toward rapid wear of the tool close to the cutting edge, and therefore toward slow cutting speeds." It will be shown in this article how the structure, that is, the crystalline make-up of cast iron controls this abrasive action and is responsible for the peculiar cutting action. The subject will be treated in a practical manner so that the machine shop man may obtain a clearer mental picture of the metallurgical phase of cast iron.

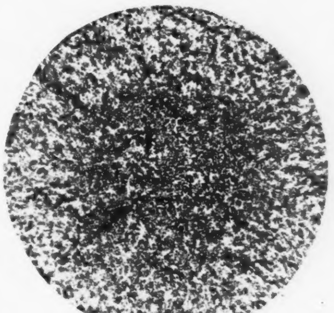


Fig. 4. Mottled Fracture of a Bar Very Low in Silicon; magnified slightly

What is cast iron made up of? Mechanically speaking, it is composed of two parts, metal and graphite flakes. A machined surface of steel will appear perfectly uniform and smooth, but with cast iron, especially the poorer grades, an ordinary machined surface is full of tiny pits which give the so-called "grain" appearance. These tiny pits contain graphitic carbon, while the rest of the structure is similar to that of steel. The graphitic carbon is the same as the graphite commonly used for lubrication, as can be shown in a number of ways. For instance, if a freshly machined steel surface is rubbed over with the hand, no dirtying of the hand results, but if cast iron is rubbed, the hand becomes covered with a black, shiny substance exactly the same as would be obtained by rubbing graphite or pencil lead between the hands.

Another test is to take half a glass of some heavy liquid that evaporates easily, such as chloroform, and shake up fine cast-iron drillings in it. If the upper liquid part is then poured off, and the chloroform is permitted to evaporate, a black shiny substance is left which a magnet will not attract, acids will not dissolve and which will burn, after long heating, without leaving an ash. This black substance is certainly not iron, and a chemist will show that it is pure carbon. He can also show that if cast-iron drillings are dissolved in iron, these black carbon graphitic flakes will remain. If a piece of cast iron is polished carefully, the microscope may be used to show that the metal is filled with these flakes of many shapes and sizes.

Fig. 1 shows a photomicrograph in which the black formations are graphite flakes, and the white portions, the surrounding metal. As these flakes have practically no strength, more and bigger flakes mean weaker and more open metal. Summarizing, it may be said that gray cast iron is a sort of steel containing myriads of flakes of weak, graphitic car-

Fig. 5. Coarse Graphite Flakes in a Weak Open Cast Iron; Magnification, 50 Diameters

Fig. 6. Photomicrograph of a Very Weak Open Iron; Magnification, 100 Diameters

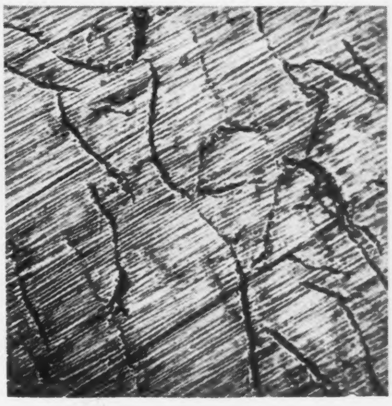


Fig. 7. Iron shown in Fig. 6 after being ground; Magnification, 100 Diameters

bon. Gray iron and semi-steel are structurally in the same family.

How Graphitic Carbon Influences Strength and Appearance

Graphitic carbon is not an abrasive; instead it is an excellent lubricant. Mr. Taylor's idea about the abrasive action of some component in cast iron was all right, but the abrasive is not graphite. What the component is will be shown later. Graphitic carbon influences the strength and finish of the metal, because fractures follow the graphite flakes to a great degree. This is logical, since the fracture naturally follows the path of least resistance, and the graphite flakes constitute the weakest component. The path of a fracture in a piece of gray iron is shown by the photomicrograph in Fig. 2. It will be noted that the break follows the line of the graphite flakes.

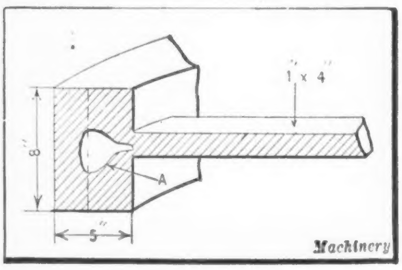


Fig. 8. Casting having a Shrinkage Cavity

Every machinist knows that the fracture of a piece of iron gives a good clue to its strength; a fine light gray fracture indicates a strong iron, while a coarsely crystalline jet-black fracture indicates a weak open iron. The size, amount, and distribution of the graphite flakes determine the sort of fracture. The photomicrograph in Fig. 3 shows a much stronger metal than that in Fig. 5. The writer purposely avoids discussing the effects of other structural components, because the graphite is by far the most positive indicator of physical properties.

The graphite flakes are also one of the major factors affecting the appearance of machined cast iron, as small flakes give a close grain, and large coarse flakes, an open grain. The shop man likes a close-grained casting if it is readily machineable, because it enables him to turn out a good-looking job without difficulty, and the customer wants close-grained castings because they indicate strength. However, the buyer would not always favor the casting of closest grain appearance if he knew that the machinist can vary the appearance at will. In other words, of two castings, the one that has apparently the closer grain may, in reality, be the weaker one, because an open-grain casting can be given a high polish by taking a number of finishing cuts, filing, grinding, peening over the edges of the pits, etc. Fig. 6 shows a cast iron that is very open, and Fig. 7 shows the same casting after the graphite flakes have been considerably closed by a machine finish.

The metal may also be torn apart at the graphite flakes in machining and make a casting look worse than it really is. However, the metallographist can tell positively which iron is the weakest by looking at the true grain size, as shown by the graphite flakes under the microscope. While the machinist can make a little time in roughing a soft open-grained iron, he loses this advantage in the greater time required for the extra finishing cuts necessary to make a presentable job.

Sometimes the same piece of cast iron has different grain appearances. There are a number of reasons for this: first, heavy sections will always be somewhat closer grained than light sections, because the slower cooling rate of the heavy sections allows more time for grain growth. Then, also, cuts of different depths may be taken on the same heavy section, and in such instances, the deeper cut will show a more open-grained iron, because the slower cooling toward the center of the section permits grain growth. Near the outer edge of even weak irons, say for the first 1/4 inch of depth, the metal will be fairly close-grained. Then from 1/4 to 2 inches in depth, there is a rapid increase in grain size in weak irons and some increase in the better grades. From a 2-inch depth on, there is little increase. These figures are only rough approximations, because the grain is affected by the composition of the iron, the total depth of the section, and other factors.

Sometimes one part of a large finished bed casting will be more open-grained than another, which is probably due to warpage. Where there has been warpage, more metal must be removed at the high spots, and consequently at such points the metal will have a more open appearance. Some castings have local areas of very open-grained spongy metal, and in some cases there may even be jagged holes. These areas result from shrinkage, and are most commonly due to faulty design of the casting. Fig. 8 illustrates a familiar example of shrinkage in a casting caused by faulty design, low-temperature pouring, and other factors. The example consists of a large gear in which there is a shrinkage cavity A that extends beyond the base of the teeth. The reason for this defect is that the arm is proportionally too thin, and as a result, when the iron contracts in cooling, the arm pulls away the still liquid metal at A. Trouble may be overcome in such a case by thickening the arm, providing large fillets where the arm joins the rim, and casting with the metal at a higher temperature. In casting solid cylinders, shrinkage holes are frequent in the wall due to the outside and top of the casting cooling before the inside is set, with the result that the internal liquid metal feeds the outer portion. The structural quality of the metal has no influence on blow-holes or cold shuts in a casting.

Hardness of Cast Iron

It is often said that hardness determines the machineability of metals; this is true in a large measure with steels, an increase in Brinell hardness usually meaning increased difficulty in machining the steel. The Brinell hardness test gives an approximate indication of the ultimate strength. However, when cast iron is considered, the problem is entirely different. The Brinell hardness of the best semi-steels is around 200, and the transverse test, around 4000. Semi-steels of such values should machine well, but cast iron may or may not, because, while the hardness, as indicated in a Brinell test, plays a part in the machineability of cast iron, the "abrasive hardness" is a big factor.

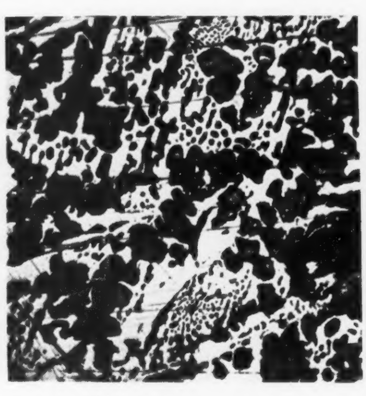


Fig. 9. Specimen etched with Picric Acid, the White Structure being Cementite; Magnification, 100 Diameters

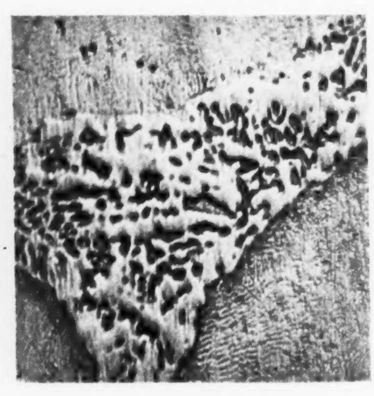


Fig. 10. Specimen polished to show Steadite; Magnification, 600 Diameters

The machinist has probably worked on castings which machined as though they had sand in the metal as well as on the outside; the metallographist has found out the reason for the difficulty experienced in the machining. First, white and mottled irons will be considered briefly. We have all seen chilled irons that were difficult to cut. Fractures of such irons may be white along the part where the chill was placed, or the whole iron may show a mottled fracture, as in the photomicrograph reproduced in Fig. 4. The intensely hard white component of such irons is cementite, a carbide of iron, which may be better seen in Fig. 9. Such white and mottled irons may be produced deliberately by

chills or unintentionally by pouring iron too low in silicon and carbon into thin sections. Iron castings of this nature are properly used when great hardness and resistance to wear are needed, such as the service required of hard rolls, old type cast-iron car-wheels, etc. A completely white iron is brittle and weak in the transverse test.

If a piece of cast iron that is gray and free from the white cementite is polished for a long time with a fine abrasive against a soft backing, the harder portions will stand in relief as shown by the photomicrograph in Fig. 10. Metallographic investigation has shown that the component standing in relief is a phosphorus rich formation known as steadite, a component that is very hard. Its hardness on the Mohs scale is 5.5, which is about equal to the hardness of feldspar and not far from that of quartz sand. Steadite is distributed throughout the metal and gives the abrasive action previously mentioned. This action is more apparent in the stronger metals, being modified in irons containing less than 0.50 per cent phosphorus, because there is less steadite in them. It may also be that the steadite of low-phosphorus irons is not so hard as that of irons higher in phosphorus.

An example will show what trouble a high phosphorus content in iron castings may cause in the shop. A company for whom the writer is consulting metallurgist makes high-grade dryer rolls for paper mill machinery. These rolls range from 4 to 5 feet in diameter and from 10 to 15 feet in length, have seamless heads, and are cast with walls about 1⅛ inches thick. The castings must have a high strength and finish well. It happened one time that the foundry had to use a pig iron much lower in silicon content than the pig iron ordinarily used, and also low in phosphorus. It was decided that the strength of the resulting castings would be satisfactory, but the foundryman and the writer had doubts about their machineability. However, this factor was found satisfactory in practice. The phosphorus content was about 0.30 per cent.

Some time later the foundry again could not obtain the pig iron ordinarily used, and decided to use a pig iron having a phosphorus content of between 0.70 and 0.80 per cent. The writer had had enough experience with phosphorus in the laboratory and shop to advise against using this pig iron, but the foundryman, encouraged by his former experience, could not understand why a few tenths per cent of phosphorus could cause trouble. However, after the first five castings had to be thrown away because they could not be machined, he revised his opinion. In the first instance, the castings were evidently just inside the limit, but in the second case, the increased abrasive action caused by the extra phosphorus made the castings unmachineable. The writer is willing to state that if the rest of the mixture and the melting conditions are all right, a little phosphorus one way or the other will not make much difference to the foundry. On weak irons the phoshorus will make little difference in machining, but on high-test semi-steels the phosphorus may prove a deciding factor in the machineability.

* * *

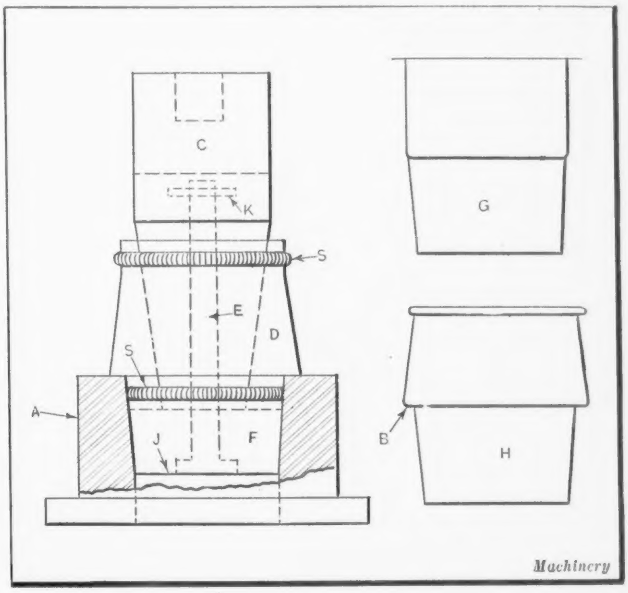
SWELLING DIE FOR ALUMINUM SHELLS

By GEORGE R. CASTER

Swelling dies of the type shown in the accompanying illustration are used in the manufacture of aluminum cooking utensils. The particular die shown is employed for swelling the shoulder on rice boiler insets. The blank for this part is first drawn into a shell of the shape shown at *G*. After being trimmed and beaded, the shell is ready for the swelling operation which produces the finished utensil shown at *H*. The die *A* is made of cast iron and is machined to take the shell up to the shoulder *B*. The thickness of the knock-out pad *J* determines the length of the bottom part of the inset.

The swelling punch is made up of the shank *C*, the segment ring *D*, the pin *E*, the bottom plate *F*, and two coil springs *S* ⅜ inch in diameter. The shank *C* is made of cast iron, and is bored and threaded to fit the press ram. The lower end is taper-turned to fit the bore of the segment ring *D*, which is tapered to an included angle of 30 degrees. The shank has a cored slot 1 by 2 inches and a 1-inch hole bored into this slot from the bottom end. Ring *D* is made of 70-point carbon Bessemer steel and is turned to fit the inside of the finished shell. It is also bored out so that when it is cut into ten segments with a ⅛-inch saw and the segments placed together, the taper end of the shank *C* will swell or expand them to the original size. The grooves above and below the formed section contain the ⅜-inch diameter coil springs which draw the segments together after they are spread by the shank *C*.

The bottom plate *F* holds the segments in a uniform position when they are assembled on the shank *C* with the pin *E*. This pin is a sliding fit in the 1-inch hole in the end of shank *C*, and has a ⅜-inch hole in the end for a pin that is inserted through the slot cast in the shank, to hold the various punch members together. It has been found that if the segment ring *D* is assembled and just enough metal



Die used to produce Shell shown at H

removed from the formed section to eliminate the high points, breakage will be reduced to a minimum. It has been found also that the edges of the segments and the spaces between them when they are expanded, cause most of the shell breakage. By turning the segments so that they come into contact with the work at their center, breakage of shells is practically eliminated.

When the die is in operation, the shell is placed on top of the knock-out pad, and when the punch descends, the bottom plate *F* comes in contact with the bottom of the shell and stops. The shank *C* then continues to descend, causing the segment ring *D* to expand. On the up stroke, the coil springs draw the segments together again. When the ⅜-inch pin *K* strikes the bottom of the slot in shank *C*, the whole punch assembly moves upward until it clears the shell. With dies of the design shown, the press must make two strokes for each shell, the shell being moved one-half the width of one segment after the first stroke.

* * *

It has been estimated that if railroad traffic increases in the next ten years at only half the rate at which it increased in the last ten years, an expenditure of approximately $800,000,000 per year will be required, in addition to ordinary maintenance charges, to keep pace with the growth of business needs. In the last forty years, railroad freight traffic has increased so that it is now eight times what it was in 1885. In the last twenty years it has more than doubled. This increase is considerably in advance of the population increase.

Follow-up System for Purchases

By WILLIAM J. HISCOX

IN many industrial plants there is no follow-up system for outside supplies, a condition that is often due to the belief on the part of the management that any effective action in this direction would involve a good deal of duplicate and extra clerical work. In such plants outstanding orders are usually referred to at irregular periods, and reminders are dropped only occasionally to the firms concerned. This method does not insure that materials will be available when wanted, and as a result it is frequently impossible to carry out the manufacturing program on time. Often it is not until an inquiry is received from the department wanting the supplies that the purchasing agent takes action, and then it is usually too late to obviate delay, as the supply of material on hand has run out.

A follow-up system is just as essential in the purchasing department as in the manufacturing departments, because production cannot be maintained unless there is an adequate supply of material available. Even if the plant follow-up system is such that an inquiry reaches the purchasing department early enough to obviate delay, if the inquiry is acted on promptly, this method of following up outside orders has little to commend it. Just as every plant order is scheduled through the various stages of manufacture, so should every order for outside supplies be scheduled.

The System should be Simple

The follow-up system for purchases can be a simple affair and need not call for extra clerical help. Some firms consider it more desirable for the production department to handle the follow-up of purchases, because it is more familiar with the actual requirements of the plant than the purchasing department and it may be relied upon to follow up the orders.

If this procedure is followed, a copy of the actual purchase order should be sent to the production department, after which the purchasing department should have no further interest in the order until the material is received, at which time the purchasing agent should enter the particulars on his record and send the invoice through for payment. With the exception of the price, the production manager should receive full details concerning the purchase on his copy of the order, including the name and address of the concern from whom the purchase was made, the quantity and nature of the materials purchased, the date specified for delivery, and the job number for which the supplies are required. Whenever necessary, the production manager should get into direct touch with the seller by letter or by telephone with a view to speeding up delivery. The forms and method of running a follow-up system for purchases will be given in detail in this article. This system may be operated either by the purchasing or the production department. The routine is based on the purchase order, and there is no necessity for writing detailed lists.

COPY

PURCHASE ORDER NO. 5471

TO Messrs Renton Engineering Co.
London Oct. 25th 1923

QUANTITY

1000 Brass Terminals to our
Blueprint No 10781 attached

DELIVERY 500 in 14 days
Complete in one Month

As per your quotation of the 21st instant

REQUISITION NO. 1978 FOR Stock

Machinery

Fig. 2. Copy of the Purchase Order which is furnished to the Follow-up Clerk

Purchase Order Register and Requisition Slip

Upon receiving a copy of the actual purchase order such as shown in Fig. 2, the clerk enters the essential information in a purchase order register, as illustrated in Fig. 1. This information covers the order number, date of order, name of concern from whom the supplies are bought, requisition number, and job or purpose for which the supplies are required. The final right-hand column is left blank until the material is received, when the date of delivery is entered.

The purchasing agent cannot place an order with a concern unless he receives authority to do so from some such person as the works manager, chief storekeeper, or head of a manufacturing department. The authority is given on the slip shown

PURCHASE ORDER REGISTER

P. O. NUMBER	DATE	PURCHASED FROM	REQUISITION NUMBER	DATE	REQUIRED FOR	DATE COMPLETED
7391	10/17/23	McLellars & Co	1016	10/14/23	Job 10378	
7392	"	J. Durrant & Co.	1016	"	" 10378	
7393	"	Renton Eng. Co.	3127	10/12	Stock	10/24/23
7394	"	British Mfg. Co.	3128	10/13	"	10/25
7395	10/18	Edwards & James	5171	"	Maintenance	
7396	"	Cooper & Turner	8772	10/15	Office Supplies	
7397	10/19	Richards Ltd.	10032	"	Store Sundries	10/22
7398	"	J. H. Buckfield	10032	"	"	10/29
7399	"	Goodson & Sons	3129	10/16	Stock	
7400	10/20	Renton Eng. Co.	3130	"	"	

Machinery

Fig. 1. Register in which is entered Information concerning Each Purchase Order

REQUISITION FOR OUTSIDE SUPPLIES No. 1978.

TO PURCHASING DEPT. FROM Stores DATE Oct. 17th 1923

PLEASE PURCHASE THE FOLLOWING FOR Stock

QUANTITY	PARTICULARS
1000	Brass Terminals Part No. 10781

WANTED BY one month SIGNED J.S.C. CONFIRMED W.H.J.

Machinery

Fig. 3. Requisition Form used for ordering Supplies from Another Concern

in Fig. 3, but the form must bear the signature of the person authorizing the purchase. It can be the rule that all requisitions must be countersigned by the works manager after being made out by the person actually requiring the supplies, such as the head storekeeper, superintendent, or works engineer. The requisition number appears in each instance on the purchase order, and is entered in the purchase order register so as to enable the follow-up clerk to identify the purchase order based on a certain requisition. When parts are bought for a specific plant order, the number of that order is entered in the register, but if the parts are intended for stock or maintenance, the appropriate word is substituted. As the numbers of the purchase orders run consecutively, it is easy to locate any order in the register and it is also easy to see the number of outstanding orders at any time or the number issued on any one day.

Forms for Following up Orders

After the particulars have been entered in the register, the name of the concern from whom the purchase has been made, and the order number, are entered in a book (see Fig. 4) that is alphabetically indexed. This brings together the numbers of all orders placed with one firm and saves correspondence, because all outstanding orders with one firm can be readily referred to in a single letter. All communications respecting the orders placed with one firm are enclosed in a single envelope for convenience. The register is also useful as a reference when a firm neglects to mention the number of the order to which a letter refers.

OUTSIDE PURCHASES

NAME	PURCHASE ORDER NUMBERS
Rice Co.	~~5722~~. ~~6743~~ ~~6748~~
Renton Eng. Co.	~~5471~~ ~~5480~~ ~~6321~~ ~~6357~~ ~~7393~~
	~~7400~~
Richards Ltd.	~~5620~~ ~~5847~~ ~~5847~~ ~~6380~~ ~~6672~~ ~~6770~~
	7397.
Pight Lonsdale Co.	~~6853~~.
	R
	S
	T

Machinery

Fig. 4. Page of Book in which All Orders placed with One Concern are entered together for Quick Reference

The final slip used in following up purchases is the reminder form shown in Fig. 5, the only entry being the order number, which is placed in the column under the date on which the supplies are expected. For example, if an order is dated November 23, and the supplies are to be delivered in fourteen days, the entry appears under December 7. On that date the follow-up clerk automatically brings the order up for review unless the supplies are received in the meantime, in which case the entry is cancelled. The fact that all purchase order numbers appear on this reminder form insures that every order will receive attention, and, in addition, the method allows a reasonable number of orders to be handled every day.

All the entries mentioned take but a few minutes daily, even when a dozen or more orders must be handled. When the entries have been made, each purchase order is placed in a manila folder on which the order number is marked in pencil and which is filed consecutively in a cabinet. By writing the order number in pencil, the folder may be used several times, because when an order is completed, all memoranda relating to the order are taken from the folder and filed elsewhere, as will be explained. This completes the preliminary work associated with the system, which is done the first thing every morning.

The Actual Follow-up

Early each afternoon the follow-up clerk looks at the reminder form and takes from the cabinet all folders bearing numbers corresponding to those appearing on the form under the date in question. From a glance at each order may be seen the terms of delivery, and as the contents of the folder include the correspondence and delivery notes, all essential information relating to the order is at hand. Inquiries are then made by the follow-up clerk to learn whether word has been received that the purchase has been dispatched or whether the material has been received during the early part of the day. If the answer in each case is in the negative, a "speed up" letter is sent to the firm with whom the order was placed, or when convenient, the telephone is used, all promises obtained by the latter means being afterward confirmed in writing.

As each order is dealt with, the corresponding entry on the reminder form is cancelled and a fresh entry made under a later date. Assuming that the orders listed under November 26 are being considered, certain of these are "speeded up," and are reentered on the reminder form in the column dated November 29. This means that on the latter date these orders will again come up for review unless the material is received in the meantime or a promise is obtained for delivery on a certain date. In the first case, the entry is cancelled, and in the second, the date is again extended to correspond with the promise made. When all orders for the day have been considered, all entries on the reminder form under that date should have been cancelled. The folders are then returned to the cabinet.

Notification of the receipt of purchases is made on the form

REMINDER. NOVEMBER

1	2	3	5	6	7	8	9	10	12	13	14	15	16	17	18
~~7395~~	~~7393~~	~~7394~~	7391	~~7399~~	7405	7392	7411		~~7401~~			~~7408~~			
~~7397~~	~~7398~~	7403	7396	7404	7410	7400			7402						
~~7404~~	7409	7407	~~7395~~		7406										
~~7406~~	7413		7412												
~~7414~~															

Machinery

Fig. 5. Form on which Orders are entered according to the Date of Delivery so as to facilitate the Follow-up

shown in Fig. 6. For all supplies received during a given day, such a notification should be in the hands of the follow-up clerk by evening of the same day. When these "Material Received" forms reach the follow-up clerk, the folders bearing the corresponding numbers are taken from the cabinet and the routine then is as follows: (1) If the form covers a part delivery, the date and the quantity received are entered on the purchase order, the entry on the reminder form is adjusted, the "Material Received" form is placed in the folder with the order copy, and the folder is returned to the cabinet. (2) If the delivery note covers a complete delivery, the order and all correspondence relating to it are taken from the folder. The order itself is then cancelled with a blue pencil and the date of completion marked on it; the entry in the purchase order register is cancelled by inserting the completion date in the final column in red ink; and the order number beside the name of the outside concern in the record of outside purchases is cancelled in red ink. If the purchase concerns only one specific plant order, the contents of the folder, together with the "Material Received" slip, are filed with that order. However, if the purchase covers parts for stock, maintenance, etc., the contents of the folder are placed in a classified file which is indexed as follows:

MATERIAL RECEIVED SERIAL NO.

SOURCE OF SUPPLY ________ DATE ________

ORDER NO.	NO. OF CASES	CASE MARKED	RAILWAY OR CARRIER	CONSIGNED AS	QUANTITY	WEIGHT TONS	WEIGHT LBS.	CHARGES (IF ANY)	REJECTS (IF ANY)

SIGNED ________

Machinery

Fig. 6. Slip on which Notice is sent to the Follow-up Clerk of Purchases delivered

Section 1. (a) Oils and Greases
(b) Rags, Cotton Waste, etc.
(c) Soap, Soap Powder, etc.
Section 2. (a) Brooms and Brushes
(b) Painters' Tools and Brushes
Section 3. (a) Chemicals
(b) Patent Compounds
(c) Paints and Varnishes
Section 4. (a) Fiber, Asbestos, etc.
(b) Leather Belting
(c) Rubber
Section 5. (a) Electric Motors, Lamps, etc.
(b) Switches, Batteries, etc.
Section 6. (a) Plant Renewals and Additions
(b) Consumable Tools
Section 7. (a) Aluminum (Sheet, Bar, and Tube)
(b) Copper and Brass (Sheet, Bar, and Tube)
Section 8. (a) Steel and Iron (Sheet, Bar, and Tube)
Section 9. (a) General Office Supplies
(b) Drawing-room Supplies
(c) Printed Records (Cards, Forms, etc.)
(d) Publications

* * *

In the Ford Motor Co.'s plant in Detroit approximately 35,000 machine tools are in use. Considering that the life of a machine tool that is constantly in operation, as most of the tools in this plant are, is only about seven years, the replacement business alone should reach about 5000 machines annually. Of course, the life of some machine tools is longer, but machines that are operated in three shifts are giving a good account of themselves if they last on an average of seven years, which is equivalent to twenty-one years of regular one-shift production.

SHOULDER-GRINDING WORK ON A CENTERLESS GRINDER

By H. J. GUSTAV KOPSCH

The operator of a centerless grinder, who was engaged in shoulder-grinding tappets, spring bolts, and similar parts, found that frequently the beveled high-speed steel or stellite plates that supported the work between the abrasive and the friction wheels would break. On investigation, it was found that the breakage was caused by pieces that were over-size or much larger in diameter than the specifications called for. In a lot of several thousand pieces, there were often some pieces that were too large, even though all the work was supposed to have passed inspection before being delivered to the grinding department.

The space allowed between the work and the two wheels of the centerless grinder, when placing the shouldered work in position, was about 0.030 to 0.040 inch, which was ample except in the case of an over-size piece. When an over-size piece was fed between the two wheels, it was suddenly knocked from the operator's hand and driven down upon the supporting blade with sufficient force to break or chip the latter member. In order to eliminate this trouble, the writer had some snap gages made, which could be easily secured to the edge of the grinding machine with C-clamps. These gages were casehardened, and ground about 0.020 inch larger than the finished size of the work. As most of the work was to be finished to fractional sizes ranging from 1/2 to 1 1/2 inches in diameter, a set of snap gages was made to meet these requirements, and the size of each gage stamped on its side.

With the correct gage clamped to the side of the machine, the operator simply picks up a piece to be ground, tries it in the gage, and then inserts it between the wheels in the usual manner, provided it passes between the contact points of the gage. This gaging operation is repeated on the next piece while the one previously gaged is being ground.

Any pieces that do not pass the gage are put aside and later ground to size in two operations. It was found that the gaging operation required practically no additional time, and the production was increased. The upkeep expense of the grinding machine was also considerably lessened, as the cost of replacing the work-supporting plates was from $15 to $25 a piece. It is probable that a simple adjustable fixture with two hardened steel plates could be attached to the machine in such a way as to prevent the insertion of over-size parts and could be employed to even better advantage than the snap gages.

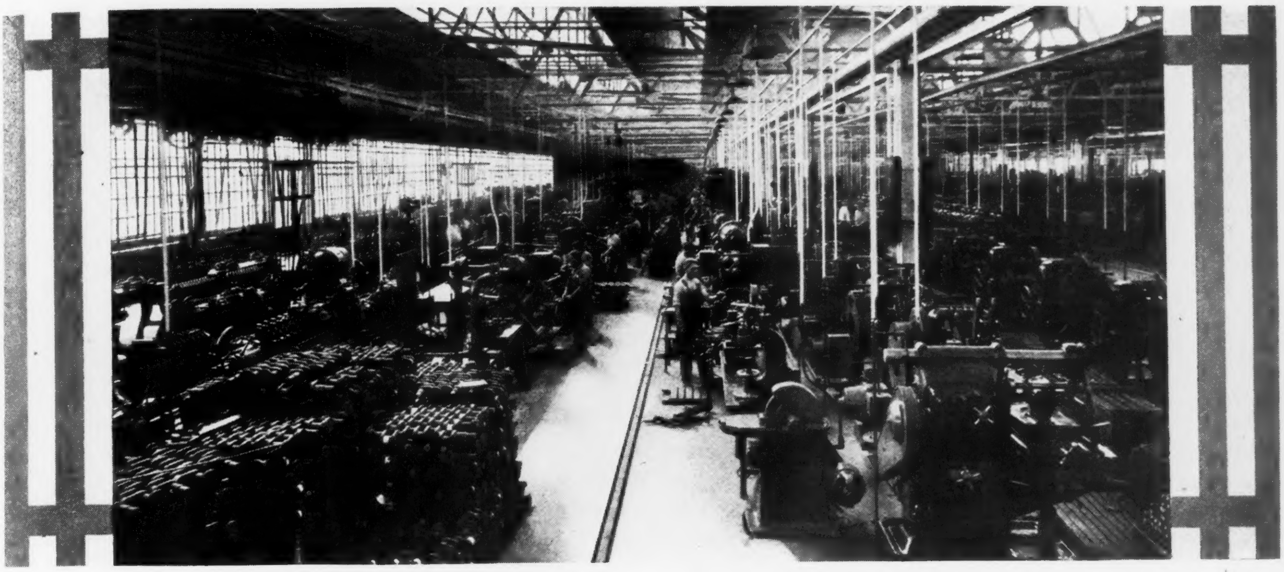
* * *

FIRST SPRING WATCHES

In November MACHINERY, in the article "Design of Helical Springs," page 205, it was mentioned that the first spring watch was produced about 1675 by Hooke. Commenting upon this statement, Adolf Dieckmann, of Cincinnati, Ohio, writes us that to the best of his knowledge, the first watches were made by Peter Heinlein, then twenty years old, in Nuremburg, Germany, in the year 1500, these watches being driven by a spring. In 1511 Heinlein made a watch with a bell ringing the hour. These watches soon were made in high-grade art work and were called Nuremburg eggs. Heinlein used bristles for the balance springs. In 1656, Huygens, a Dutchman, substituted the snail or scroll balance spring in place of the bristles, which improved the accuracy to such an extent as to make it possible to use these watches for longitudinal measurements at sea.

* * *

The British Engineering Standards Association has issued a new publication, No. 46, Part 1, giving tables of dimensions for standard keys and keyways, covering rectangular and square parallel keys. Copies of this report may be obtained from the British Engineering Standards Association, Publication Department, 28 Victoria St., London, S.W. 1, England, at a price of 1/2d.



Lincoln Crankshaft Practice

How Crankshafts are Made for a High-grade Automobile

By CHARLES O. HERB

AUTOMOBILE plants are universally recognized as having the most efficient methods of any branch of the metal-working industry. An outstanding plant in that field is the Lincoln Motor Co. branch of the Ford Motor Co., Detroit, Mich. The methods of handling the work, the grouping of machines, the modern equipment, the cleanliness, and the lighting conditions, give a very favorable impression. The heading illustration shows a typical department; a remarkable thing about this photograph is that not a piece of waste was picked up anywhere nor was the floor swept preparatory to taking it. Practically every machine in the shop is equipped with an individual motor drive. Naturally such ideal shop conditions have a desirable influence on the morale of the workmen.

In this plant attention is given to many little details solely to improve the appearance of the car. For instance, where two castings are assembled together, as the cylinder block and the crankcase, the edges at the joint of the two castings are neatly ground so that they are even with each other. In the production of the crankshaft alone, forty-three operations and fifty-three inspections are performed to insure an accurate, well balanced part. A feature of the Lincoln crankshaft is that it is ground all over for the sake of accuracy and appearance, and to reduce the effort in balancing. The more important of the operations and several of the inspections performed on the crankshaft will be described in this article.

The crankshafts come to the department drop-forged from a chrome-nickel steel with a high carbon content, corresponding to S. A. E. Specification 3140A. The Brinell hardness reading must be between 285 and 300. The weight of the rough forging is about 96 pounds, and the weight of the finished crankshaft, 46 pounds, so that over 50 per cent of the stock is removed in machining. When all rough- and finish-turning and facing operations have been performed, but before grinding, the crankshaft is subjected to a normalizing process to relieve strains and eliminate the necessity of straightening the crankshaft either between or after the grinding steps. Only rough- and finish-turning and facing cuts are taken on the various surfaces, no semi-finishing cuts.

In the heading illustration it will be seen that the rough forgings are stacked at one end of the department. From these piles the crankshafts follow a zigzag path between the two long rows of machines, and when the opposite end of the department is reached, the work is ready for balancing and final inspection. The crankshafts are carried by trucks that travel along a track running between the two rows of machines. Both ends of the crankshafts are provided with initial centers in the forge shop, to guide the center drill subsequently used.

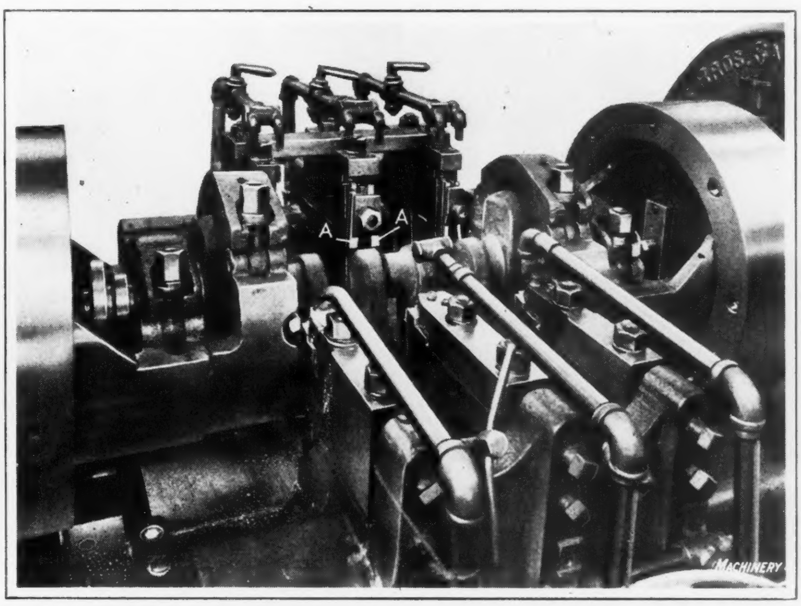


Fig. 1. Tooling provided on Lathe for simultaneously rough-turning Three Bearings and rough-facing the Adjacent Crank Cheeks

The first operation consists of applying one crank-arm profile to the grinding wheel of a floor stand to produce a clean surface for taking a Brinell hardness reading. The grinding operation and the hardness test are performed on the first two machines shown in the fore-

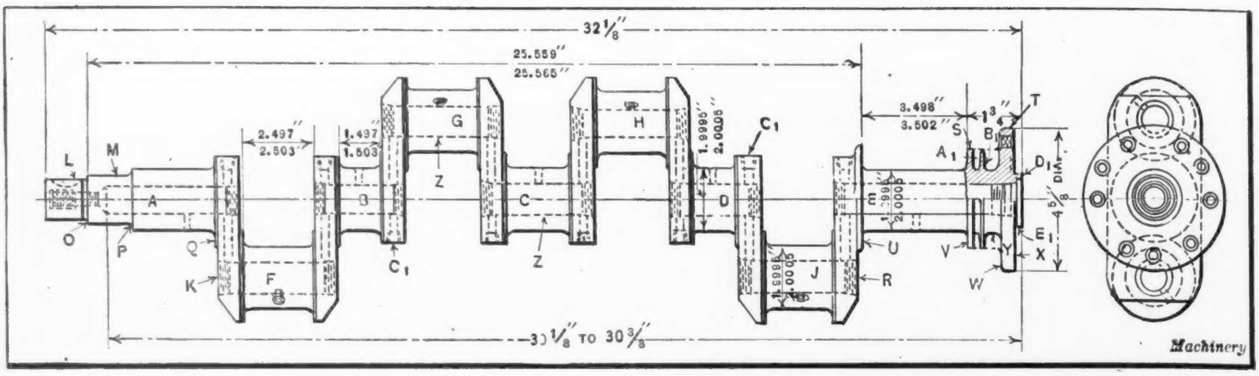


Fig. 2. Four-throw Crankshaft used in Lincoln Eight-cylinder V-type Automobile Engine

ground of the heading illustration, to the right of the track. The crankshaft is then passed across the track to a light sensitive drilling machine, where it is held vertically for drilling and countersinking the centers in each end. A checking fixture is next employed to determine whether there is enough stock on the crank cheeks and other surfaces so that the part can be machined to the required dimensions. In this fixture the crankshaft is held on centers and a templet having a series of slots corresponding with the crank cheeks is swung down over the work. If there is sufficient stock on the cheeks, it will project beyond the edges of the different slots. A gage at the rear of the fixture is pushed forward to determine whether the crankpins are properly located relative to the center of the main bearings.

Operations Performed in Crankshaft Lathes

All surfaces with the exception of the crank-arm contours, are next turned or faced in a battery of five Wickes crankshaft lathes. The tooling for the third of these operations is shown in Fig. 1. In the first operation, cuts are taken on the gear end of the crankshaft; this end is held on the tailstock center and the opposite end in a pot chuck that extends to the crank between bearing *D* and pin *J*, Fig. 2, so as to adequately support the work. An indicating lever attached to the rear tool carriage is swung forward before clamping the work in the chuck, so that cheek *K*, which bears an index mark put on by the forge shop at the same time that the initial centers were placed in the shaft, is properly located in relation to the cutting tools. This method equalizes the finish on all shoulders and crank cheeks. Four tools on the front carriage turn surfaces *L*, *M*, and *A* and face cheek *K*, after which three tools held vertically on the rear carriage are advanced to face shoulders *O*, *P*, and *Q*. The front tools, of course, are fed to depth and then horizontally along the work, while the rear tools have only a forward movement. The turned surfaces are checked with micrometers. About 1/8 inch of stock is removed from the different surfaces in this and the succeeding roughing operations in the lathes, the surfaces being machined to within 0.010 inch of the finished size.

In the second lathe, the flywheel flange end of the work is supported on the tailstock center and the gear end just machined is held in a pot chuck of the same type as that used on the preceding machine. Three tools on the front carriage of this lathe face cheek *R*, and turn bearing *E*, surface *S* (to flange *T*, as indicated by the dotted lines), and flange *T*. Next four vertical tools on the rear carriage face *U*, *V*, *W*, and *X*. Neck *Y* is then cut from the solid by means of a tool fastened to the front carriage.

In the third lathe operation illustrated in Fig. 1, bearings *B*, *C*, and *D*, Fig. 2, are turned, and all adjacent crank cheeks are faced. This lathe is of the Wickes duplex type, being equipped with a substantial chuck at each end for holding and driving the work. Bearings *A* and *E*, which were previously rough-turned, are now located by bearings in these chucks, clamps being tightened on the adjacent crankpins. Both the front and rear tool carriages are provided with three holders, so arranged that the tools can be advanced between the crank cheeks. Each front holder carries three tools, and each rear holder, two tools, as shown at *A*, Fig. 1, making a total of fifteen tools on the machine. The two side tools on each front holder are spaced so as to take a cut on two adjacent crank cheeks. The carriages feed toward the center of the machine, the tools on both front and rear holders being fed at the same time to take cuts on the same cheeks. The middle tool on each front holder projects beyond the side tools to permit turning the bearings in conjunction with the rear tools. It will be apparent that there is no longitudinal movement of either carriage in this operation. Individual streams of cutting lubricant are fed to the various tools. In each of the lathe operations, the cylindrical surfaces are turned to micrometers and gages, and all shoulders are faced to snap gages. In the operation just described, for instance, three gages are used to check the distance between the different crank cheeks.

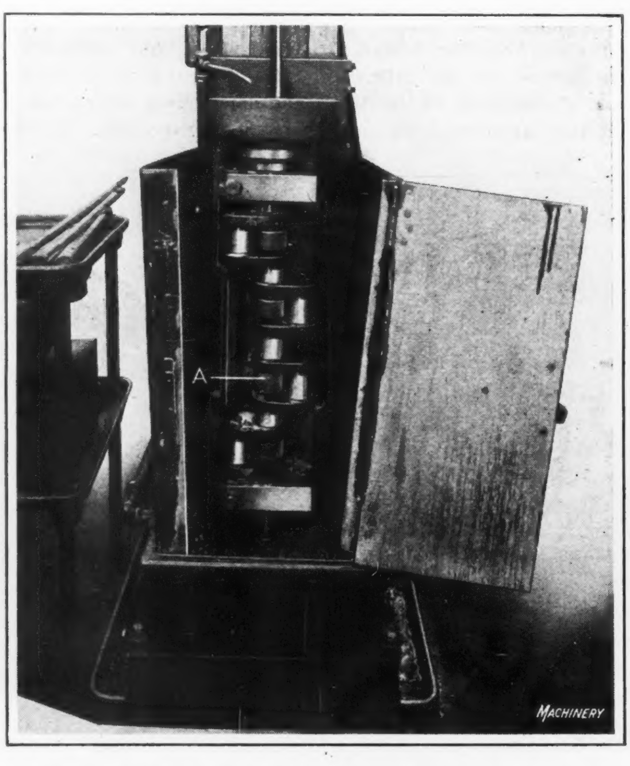


Fig. 3. Set-up used on a Vertical Drilling Machine for drilling a One-inch Hole through each Bearing of the Crankshaft in One Operation

After the third lathe operation, the crankshaft is taken to a Norton grinding machine for rough-grinding bearings *A*, *B*, *C*, *D*, and *E*, Fig. 2. For this operation the work is held on centers and a backrest is used at bearing *C*, each bearing being ground to a given diameter within 0.005 inch. The object in rough-grinding the bearings at this time is to produce surfaces from which to locate the work accurately during the remaining operations before the final grinding.

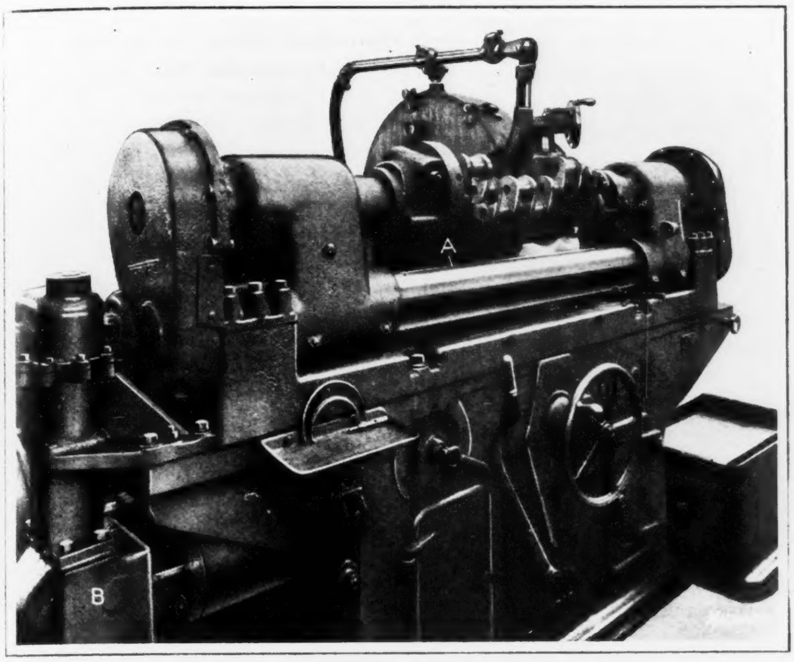


Fig. 4. Grinding Machine equipped with Special Mechanisms for simultaneously grinding the Complete Contour of Two Crank-arms

Crankpins *F* and *J* are next turned and their adjacent cheeks faced in a crankpin lathe, the crankshaft being again supported in and driven at each end by heavy chucks and, of course, rotating about the center of the crankpins being machined. With the exception of the number of tool-holders, the tooling equipment used in this operation is similar to that shown in Fig. 1, two vertical tools being mounted on each of two rear holders, and three horizontal tools on two front holders. In setting up the work for this operation, use is made of a punch mark which is carefully made on the edge of the crank cheek between the bearings *E* and *J* at the time that the initial centers are produced in the crankshaft by the forge shop. This also insures an equal finish on the side of the several cheeks and shoulders.

In the fifth lathe operation, crankpins *G* and *H* are rough-turned and their cheeks, faced, with a set-up identical to that employed in the fourth operation, except that longer chucks are used so as to support the work close to the cutting points. The crankshaft is next checked in a fixture by means of indicators and then straightened to the previously rough-ground main bearings under an arbor press, if this is necessary.

Drilling One-inch Holes with a Drill Three Feet Long

Lubrication of the different bearings and crankpins of the Lincoln crankshaft, when it is assembled in the automobile, is accomplished by forcing lubricant through the one-inch holes that run through the center of each bearing and crankpin, as shown at *Z*, Fig. 2, and that are connected by means of 1/4-inch holes in the crank-arms. The holes through the five main bearings are drilled in one operation with a drill almost three feet long, the distance from the flywheel end of the crankshaft to the bottom of the hole in the gear end being about 30 1/4 inches. For this operation, use is made of an upright drilling machine equipped as shown in Fig. 3. It will be seen that the work is held in a special two-station indexing jig in which a crankshaft can be reloaded while another is being drilled.

The crankshaft is supported on a hardened plug at the bottom, and is located by clamping the two end main bearings in V-blocks. There is a bushing at the top of the jig and one between each bearing, as indicated at *A*, to guide the drill. The fixture is held in the proper position by means of a lock-pin controlled through a foot-pedal. When it is desired to index the jig, the pedal is depressed to leave the jig free to be revolved by hand.

The holes through the four crankpin bearings are drilled 15/16 inch in diameter in a somewhat similar set-up, in which a double-spindle drill head is used to drill simultaneously the two crankpins on opposite sides of the crankshaft. One man attends to two machines. These holes are later bored 1 inch in diameter in order to insure that they will be equidistant from and parallel with the main bearings of the crankshaft.

Contour-grinding the Crank-arms and Normalizing

After a preliminary milling operation on the edge of all crank-arms, the crankshaft is placed in the machine shown in Fig. 4, and the entire contour of the crank-arms is rough-ground. This is a Landis machine equipped with two wheels for simultaneously grinding the two arms of one crank, and with a special work-rotating and rocking fixture. The crankshaft is clamped by means of the two end main bearings in simultaneously driven chucks of the attachment, and rotated about the center of the main bearings. While the work is rotated, the attachment is rocked back and forth to suit the outline of the crank-arms, by means of a cam arrangement provided for each work-holding chuck at the ends of the machine.

The drive to the attachment is taken from a standard horizontal shaft in the base of the machine and then through bevel gears in case *B* to a vertical shaft. At the top of this shaft is a worm that drives a worm-gear on a short horizontal shaft extending toward the right, which is provided at the right-hand end with a spur gear. This spur gear drives a gear on the left-hand end of a shaft that extends through the hollow shaft *A* to the right-hand end of the machine, where there is a second gear of the same size. From these two gears on each side of the machine, the work spindles are driven at uniform speeds through spur gearing.

Most of the stock has now been removed and the crankshaft arrives at an electrically heated normalizing furnace,

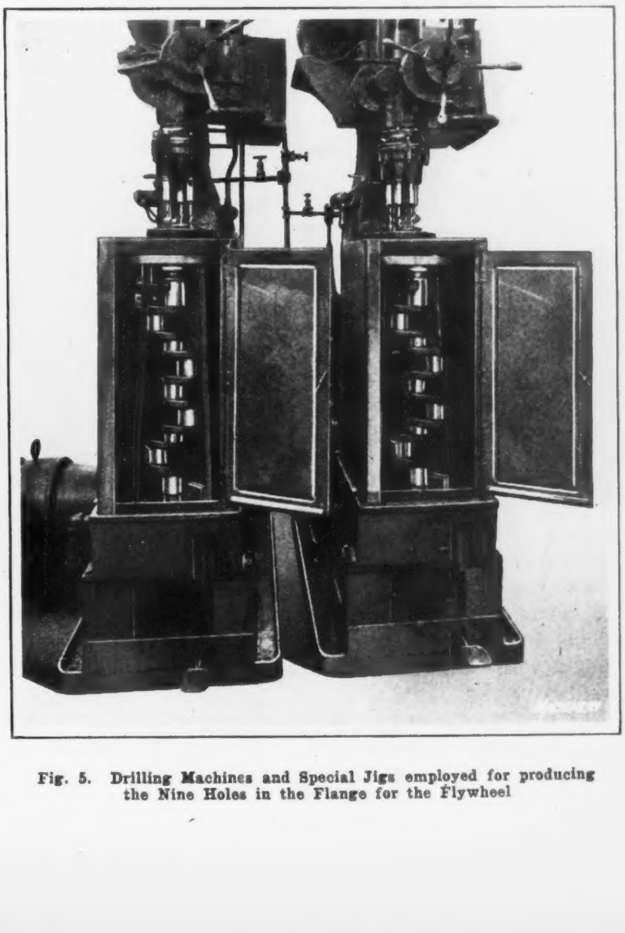


Fig. 5. Drilling Machines and Special Jigs employed for producing the Nine Holes in the Flange for the Flywheel

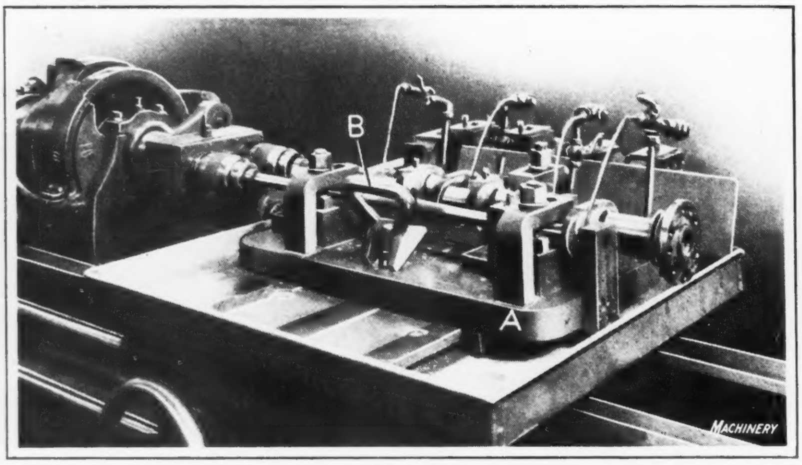


Fig. 6. Boring the One-inch Holes in the Crankpins Concentric with the Ground Bearings

where it is submerged for forty-five minutes in a solution of sodium nitrate kept at a temperature of 850 degrees F. A number of crankshafts are placed in a large wire-mesh basket, which provides a convenient means for lowering them into the tank and removing them at the completion of the operation. In this normalizing process all strains incident to the machining steps are relieved, and by doing the normalizing at this stage of the manufacture, straightening during or after the subsequent grinding operations is eliminated. The work has a dark finish when it comes from this furnace.

Finishing Cuts Taken in Wickes Lathes

After the normalizing, the crankshaft is taken to a vertical drilling machine in which a 21/64-inch hole is drilled through the gear end to meet the 1-inch hole in bearing *A*, Fig. 2, and then this end is recentered, counterbored, tapped, and faced to length. The large hole at the center of the flywheel end is operated on in the same way. The work is held in a fixture that indexes in a vertical plane to bring either end uppermost, and a quick-change drill chuck is used in which arbors containing the different tools can be quickly interchanged. The type of jig used necessitates only one location of the work for both operations.

The crankshaft is then brought to another Wickes lathe in which surface *R* is faced and surfaces *S*, *Y*, and *T* turned by tools on the front carriage. Bearing *E* is also turned part way, but not for the entire length. Surface *U*, the remainder of bearing *E*, groove A_1 and surfaces *V*, B_1, and *W* are then finish-turned or faced by five tools on the rear carriage. A special rocking tool on the front carriage is also employed to turn face *X* of the flange on the central boss E_1.

Another lathe of the same make is next used for turning surfaces *L* and *M* and bearing *A*, except for a portion adjacent to surface *Q*, these cuts being taken by three tools on the front carriage. Then four tools on the rear carriage are used to face surfaces *O*, *P*, and *Q*, and finish-turn the remainder of bearing *A*. In these two operations, the various bearings are turned to the finished diameter within 0.015 inch.

Several Drilling Operations

Holes C_1 are next drilled in the crank-arms to connect holes *Z*, on an upright drilling machine equipped with a four-spindle head and a special fixture. Nine small oil-holes are then drilled from the outside of the bearings and crankpins to the large central hole. This is accomplished under a Hammond bracket arm drill which permits moving the spindle conveniently from place to place, the work being held in a fixture equipped with drill bushings at the different points.

The next operation consists of drilling six holes through the flywheel flange with the set-up shown at the right-hand side of Fig. 5, after which the left-hand machine is used for drilling three slightly larger dowel-pin holes through the flange. Before removing the crankshaft from the second fixture, the operator reams the hole that is in line with the center of two of the crankpins, so as to provide a means of accurately locating the work in later grinding operations.

In these two drilling operations, the gear end of the crankshaft is partly located by a center and supported in a taper socket. Also for locating purposes, one crankpin and one main bearing are registered in V-blocks, and at the flange end, boss E_1, Fig. 2, is located by a spring-actuated device. Both fixtures are of the two-station type, so that one piece of work can be reloaded while another is being drilled. These fixtures, too, are locked by means of a plunger withdrawn by the foot-pedal for indexing. All nine holes through the flange are countersunk on the back of the flange, and the six to be tapped are also countersunk on the front. The next operation consists of tapping these holes.

Rough-finish Grinding the Bearings and Boring Holes Z, Fig. 2

Bearings *A*, *C*, and *E* are next ground to diameter within 0.005 inch of the finished size, and to length between the shoulders within 0.010 inch. Limit gages are applied between the various shoulders and cheeks. Then, in two succeeding operations, the different crank cheeks are ground, after which the crankpins are ground on two machines.

Hole *Z* through each crankpin, which was drilled 15/16 inch, is next bored to 1 inch to correct any "runout" due to the long drills used, or to any error that might be introduced because of a variation in the diameters of the crankpins by which the crankshaft was located in the drilling fixture. This boring is performed after all rough-grinding is completed, in order that the work may be accurately located from true surfaces so as to bore the hole at the center of the crankpins and parallel with and equidistant from the main bearings within close limits. This operation assists considerably in balancing the crankshaft at the end of the manufacturing process. For the boring operation, an ordinary engine lathe is equipped with a two-spindle head and a special fixture, as illustrated in Fig. 6.

To load this fixture and insert the two boring-bars, body *A* is slid forward on its base, in which location each boring-bar can be conveniently pushed through the work and into two bushings ready for starting the cut as soon as body *A*

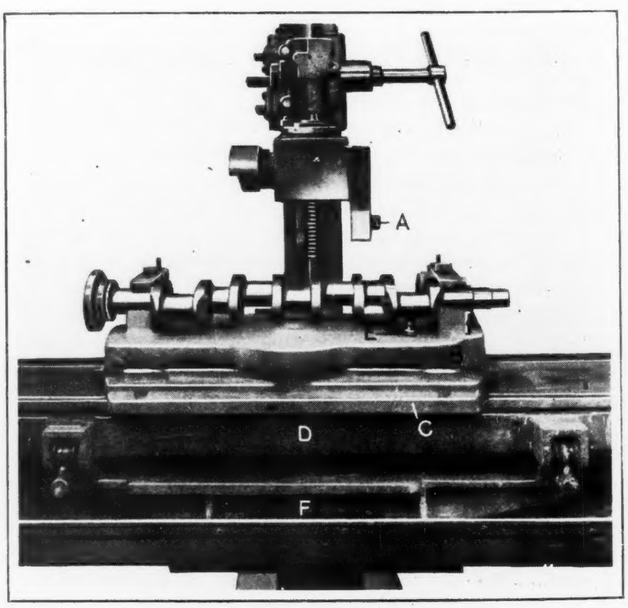


Fig. 7. Special Tool-holding Attachment and Fixture designed for reaming and tapping Each End of the One-inch Holes in the Bearings and Crankpins

has been returned to the position illustrated, and the boring-bars have been attached to the chucks. When this has been done, the regular feed of the machine is engaged to move the fixture and work along the boring-bars. During the feed, the right-hand end of each bar enters a third guide bushing to insure straight holes. Handle *B* is raised when the fixture is pushed to the rear position, causing a plunger to enter a bushing in the base and thus lock the fixture for the operation. The succeeding operation consists of milling a bevel on the different crank cheeks, and is performed in a horizontal milling machine equipped with a series of angle cutters on one arbor.

Finish-grinding and Other Final Operations

The contours of the crank-arms are next finish-ground on two machines equipped with the same set-up as that illustrated in Fig. 4, and then the crankpin bearings are finish-ground. For this operation, the wheel is approximately of the same width as the crankpins. Two crankpin bearings are ground with the work held in one position in one machine, and then the work is placed in another machine which locates it at 180 degrees from its former position for grinding the other two pins. The diameter of the pins is held to size within 0.0005 inch, plus or minus. The main bearings are next ground to diameter in another machine within the same limits, and to length within 0.003 inch, plus or minus. Then the different gear fits, the periphery of the flywheel flange, etc., are finish-ground. In each of these steps a grinding gage is used that permits the diameters to be determined without stopping the work.

An especially interesting operation that is performed at about this point is the reaming and tapping of each end of the 1-inch holes that extend through the bearings and crankpins, ready to receive threaded plugs. This operation is accomplished by means of the set-up shown in Fig. 7. It will be seen that a drilling machine is equipped with a special head in which the reamer or tap *A*, depending on the operation, is held horizontally. This attachment is driven from a bevel gear at the lower end of the machine spindle, which drives a similar gear on a horizontal shaft of the attachment. At the right-hand end of this shaft is a spur gear which drives through an idler to another gear mounted on a sleeve into which the shank of the reamer or tap is inserted. The hole in this sleeve is square, and the shank of the reamer and tap made to correspond.

In order to insert the reamer or tap into each hole, it is necessary to reverse the work and move it longitudinally and transversely. For this reason fixture *B*, in which the work is held, can be indexed on base *C*, and this base can be moved longitudinally beneath the spindle on a carriage *D*. In addition, carriage *D* may be moved transversely on a stationary table *F* which is supported by the regular machine table. The work is located for this operation by clamping the two end main bearings in V-blocks and resting one crankpin on the adjustable screw *E* and a crankpin at the rear on a block of suitable height.

The next operation consists of cutting the Woodruff keyway in end *L*, Fig. 2, of the crankshaft. This operation is performed in a hand milling machine with much care, because the keyway must be in alignment with the center line of the crankshaft within close limits, as will be apparent from an inspection to be described later. The crankshaft is then thoroughly washed in kerosene to remove all oil and chips, after which it is balanced statically on a floor stand. Any corrections necessary are made by grinding on the contour of the crank-arms. All bearings and crankpins are then polished by hand, while the crankshaft is revolved in a lathe at about 600 revolutions per minute. In doing this, very fine sandpaper held in a large pair of wooden tongs, with polishers' tripoli as a lubricant, is applied on the different surfaces until all marks of the grinding wheel are removed and a high polish is obtained.

Final Inspection Methods

In the final inspection, all bearings and crankpins are carefully examined for smoothness and absence of flaws, and then the accuracy of all threads is determined by means of plug thread gages. All crankpins and bearings are next checked for diameter by applying micrometers at six different places on each surface. Other diameters than those mentioned are inspected by means of snap gages, and the outline of the crank-arms is also checked by gages of the same type.

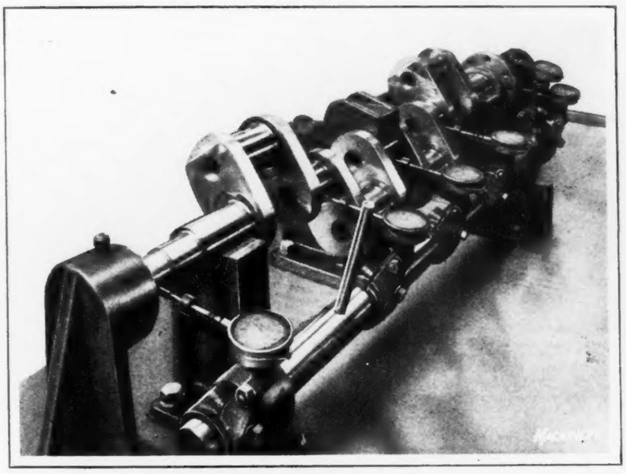


Fig. 8. Fixture for determining the Concentricity of Six Cylindrical Surfaces and the Squareness of Two Faces

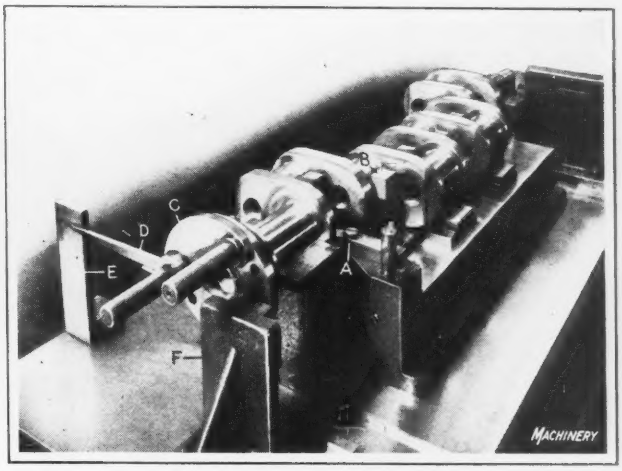


Fig. 9. Fixture employed for checking the Plane of the Various Crankpins Relative to the Main Bearings

Fig. 8 shows a fixture in which the crankshaft is next placed to determine any eccentricity or runout of six cylindrical surfaces and the accuracy of two faces. There are eight indicating dial gages mounted on the bar at the front of the fixture which may be rotated to bring the indicator points against or away from the different surfaces of the work, for convenience in placing work in the fixture. The left-hand indicator is applied to gear fit *L*, Fig. 2, and the next three to bearings *B*, *C*, and *D*, respectively. At the right-hand end there are four indicators for checking periphery *T* and face *X* of the flywheel flange and surfaces D_1 and E_1 of the pilot on this end. The work is held in semicircular babbitt-lined bearings at each end, and supported at the center bearing on a fiber-lined rest.

For checking the plane of the crankpins, use is made of the fixture illustrated in Fig. 9. The crankshaft is again supported on its bearings, and finger *A* pushes the cheek of the crankshaft endwise against a hardened block to give longitudinal location. The crankshaft is revolved until one crankpin bearing stops against a hardened block. Beneath each crankpin, all in one plane but not touching, are hardened steel blocks. Gage-blocks are slipped between the crankpins and these blocks to determine how closely all

crankpins are in the same plane relative to the main bearings. A tolerance of only 0.005 inch is allowed. Gage-blocks are also employed to check all spaces between the shoulders on the various crank-arms, the gage-blocks being slipped between all shoulders and hardened vertical blocks such as illustrated at *B*.

A finger gage *C* is employed to determine the accuracy of the location of the dowel-holes in the flywheel flange. Pins on this gage are inserted in two holes, with finger *D* extending to upright *E* at the rear. On this upright is an index line with which a line on the finger must coincide within 0.015 inch, the distance from the center of the crankshaft to the end of the finger being 8 inches. These dowel-holes are later reamed taper when the flywheel is assembled. There is also a finger indicator at the right-hand end of the fixture for checking the alignment of the Woodruff keyway with the center of the crankshaft, but this is a multiplying lever with a ratio of 8 to 1. Two tolerance index lines are placed on the upright for this lever, 0.015 inch apart. Dynamic balancing follows this inspection, any corrections necessary being made by drilling into the profile of the crank-arms. The maximum hole size for correcting purposes is 3/8 inch, and the maximum depth is also 3/8 inch.

Threaded plugs are finally screwed into each end of holes *Z*, Fig. 2. Then to guarantee that the crankshaft does not leak at a single one of the sixteen plugs, it is brought to the fixture shown in Fig. 10, where kerosene is forced into the shaft under a pressure of about 80 pounds per square inch. The hose through which the oil is forced is attached to the gear end of the crankshaft, as shown at *A*, the hole at the opposite end being also plugged shut. The kerosene is forced from a tank beneath the table, and the pressure is read from gage *B*.

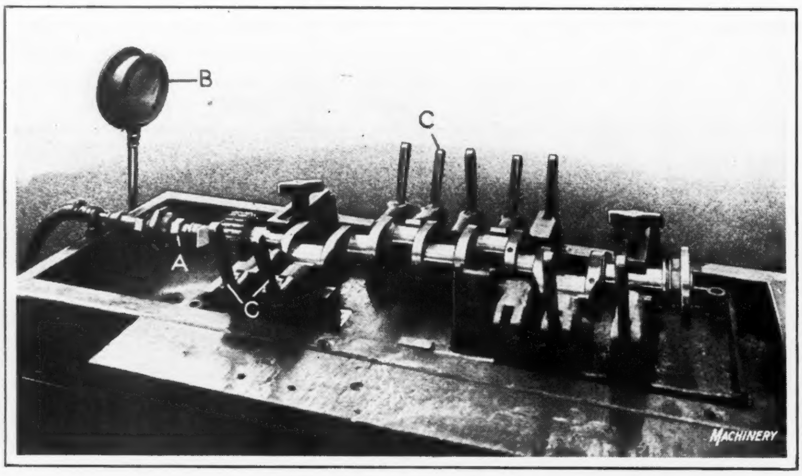


Fig. 10. Equipment used for forcing Kerosene into the Crankshaft at a Pressure of Eighty Pounds per Square Inch to determine whether the Threaded Plugs are Leakproof

The crankshaft is clamped in V-blocks at each end, after which the nine levers *C* are pushed upward to compress stoppers tightly over each delivery hole and thus make the crankshaft oil-tight for the inspection. Any plug where leakage exists is then fixed, as the crankshaft, being lubricated by a force-feed system, must be entirely leakproof.

* * *

The Egyptian imports of machine tools during the first nine months of 1924 amounted to approximately $120,000. The machine tools imported from the United Kingdom were valued at $62,000, those from Germany at $20,000, and those from the United States at about $10,000. The trade of Germany did, however, decline from what it was in 1923. In that year the United States ranked sixth as supplier of machine tools to Egypt, following Germany, the United Kingdom, Belgium, Italy, and France. The principal machine shops in Egypt belong to the state railways and the traction and steamship companies. There are also a few machine shops in Cairo, Alexandria, and Port Said, doing contract and job work. The foregoing information is based upon a report by Trade Commissioner Richard A. May, Alexandria, published in *Commerce Reports*.

* * *

Of the 15,200,000 passenger automobiles registered in the United States, 4,175,000 are used by farmers, and of the 1,800,000 motor trucks, 425,000 are used on farms.

THE GERMAN MACHINE TOOL INDUSTRY

According to the latest number of "German Trade Reports and Opportunities," published by the American Chamber of Commerce in Germany, there has been "a decided change for the better in the situation of the German machine tool industry, and although orders are booked at great sacrifices, manufacturers manage to keep their plants going." It is mentioned that the present business is exclusively in the domestic market, as the export business is practically at a standstill, due to the high prices at which German machine tool builders are now forced to quote, these being, it is stated, frequently 30 per cent higher than those of some of their foreign competitors. Several European countries have successfully taken up the manufacture of machine tools, a competition that is severely felt by the German manufacturers.

In Europe, Italy especially has been an active buyer of German machine tools, as all types of machines are in demand by the rather flourishing Italian automobile industry. The trade with Spain has recovered somewhat, but export to Czecho-Slovakia is seriously hampered by present import restrictions. There is a small export to Denmark, but the demand for machine tools in Sweden and Norway is fully taken care of by the domestic manufacturers in these countries. The Polish market affords an abundant field for machine tools, but the lack of funds on the part of Polish industries does not offer any sales opportunities for some time to come. The Balkan States are of no importance for quality machine tools, as in these sections only the cheapest kind of tools are bought. Of the non-European markets, only South America offers an opportunity.

* * *

It is stated that an increase of 20 per cent in the life of street car wheels has been effected by the Detroit street railway system through using electric welding in building up worn flanges on car wheels. When the flanges are worn to 5/8 inch thick or less, the wheels are removed and sent to the repair shop. Here a continuous automatic electric welding machine replaces the worn flange metal. A separate driving motor rotates the wheel, and the welding operation is continuous and entirely automatic. Two pieces of welding electrode, approximately 1/8 inch in diameter are kept in constant contact with the wheel at different points where the flange needs building up. The wire is supplied automatically from overhead coils, the contact and feed being continuous. The actual welding operation for one wheel is completed in about an hour. The rough surface is then refinished on a car-wheel grinding machine.

* * *

Figures compiled by A. R. Mogge, merchandising director of the Automotive Equipment Association, show that in 1923 automobile owners spent $650,000,000 for replacement parts, and $910,000,000 for labor for putting these parts on their cars. There are 70,000 repair shops in existence, of which 32,500 are car-dealer service stations and 37,500 are independent garages doing repair work. Altogether, there are 42,800 passenger-car dealers in business, of whom 74 per cent operate service stations and repair shops.

Notes and Comment on Engineering Topics

An enormous amount of leather is used in belting. The belts for the new Long-Bell Lumber Mill at Longview, Wash., for example, required the hides of 795 steers. Lumber mills are very hard on belting, so the hides for such belts are specially selected from steers killed during the summer months, when the hide is in its best condition. This belting was furnished by the Graton & Knight Mfg. Co., of Worcester. Reduced to units of one-inch single ply belting, the order called for over 94,000 feet, or nearly nineteen miles of belt.

Statistics on water power show that the developed water power of the United States is approximately 10,000,000 horsepower; of Canada 3,500,000; of Sweden 1,500,000; and of Norway and France approximately the same. Switzerland and Germany have developed over 1,000,000 horsepower each from their water resources. The potential horsepower that could be developed in the United States is estimated at 28,000,000; in Canada, 20,000,000; in Norway, 5,500,000; in France, 4,700,000; in Sweden, 4,500,000; in Switzerland, 1,400,000; and in Germany, 1,350,000.

Some of the engineering projects accomplished many years ago without the assistance of modern machinery excite the interest and wonder of engineers of today. In a paper read before the Teknik Club, of Denver, reference was made to the construction of some drainage tunnels for mines in Germany and Hungary back in the eighteenth century, of lengths unequalled in the history of mining. The Tiefe Georg tunnel in Saxony, driven between 1777 and 1779, is 34,529 feet long and has branches amounting to 25,319 feet more. This tunnel was driven entirely by hand. The Joseph II tunnel at Schemnitz was started in 1782 but not completed until 1878. It is 10¼ miles long. The Rothschönberger tunnel at Freiberg, which was driven between 1844 and 1877, is 95,149 feet in length. These tunnels were all driven by hand, using black powder.

The possibilities of savings in repair work by the use of electric welding equipment was recently illustrated at the plant of the Richardson Co. of Lockland, Ohio, manufacturer of box-board and roofing. This concern bought a new engine for direct connection to a 750-kilowatt generator which had been in the plant about twenty years and which it was decided to rewind as a safety measure. It was discovered, however, that the cast-iron spider of this generator had two cracked spokes. To secure a new spider would have meant a delay of months and an expense of about $2500. On the recommendation of the General Electric Co. the casting was repaired by using electric arc welding. In repairing the spider a vee, 1 inch deep, was cut at each fracture. The weld was reinforced with 5/16-inch steel studs, 1 inch apart. The work was completed in two days.

An interesting test run was recently made on a double-acting two-cycle Diesel-type oil engine built by the Worthington Pump & Machinery Corporation. The average indicated horsepower of the engine was 778; it was run at full power without a stop for thirty consecutive days, or 720 hours, at an average speed of approximately 90 revolutions per minute. The night following its thirty-day run it was stopped, and the following morning it was started, stopped, run in reverse, and again run ahead and stopped, although it had not been inspected or adjusted since the end of the thirty-day run. Later it was inspected and it was found that the engine, cylinder liners, piston, and rod were all in perfect condition. The piston-rings were all as free as when originally put in, and there was no marking or scoring on any surface. Evidently, the test run could have been continued for a much longer period with the same results.

The fact that 13,500 shaft horsepower is obtained from only two six-cylinder Burmeister and Wain four-stroke double-acting Diesel engines in the recently launched Swedish-American Line motorship *Gripsholm*, indicates that a distinct advance has been achieved in marine oil-engine practice. By adopting a new method of piston cooling, permitting higher working speeds, and the double-acting principle, it has been found possible to obtain over 1100 horsepower from each cylinder of these engines. The cylinders are 33 inches in diameter, the stroke being 59 inches. The *Gripsholm*, which has been built by Armstrong, Whitworth & Co., Ltd., of Newcastle-on-Tyne, is 17,000 tons gross, and has a length of 550 feet, a breadth of 74 feet, and a depth of 42½ feet from the bulkhead deck. This will constitute the first motor-driven passenger and mail ship in the North Atlantic trade.

Permanent reconstruction in Japan will not begin for three years, according to the Far Eastern Division of the Department of Commerce. An entirely new plan for streets in the cities destroyed and adjustment of land holdings will have to be carried through, and it is predicted by Japanese industrial leaders that it will be at least a decade, or possibly more, before the gigantic reconstruction program can be fully carried out. The temporary buildings now erected will not give way to permanent construction until necessity requires, and in any case they are protected by law for a period of five years. In the meantime, it is doubtful whether the city and national governments will carry out their program of reconstruction. The present temporary structures have been built on approximately the old locations and the carrying out of the ambitious street reconstruction program will require the destruction or removal of a large number of them. Hence, it is not likely that the reconstruction work will bring about any immediate business expansion in Japan.

In a recent issue of *Stahl und Eisen*, it is mentioned that the Dresler process of making bricks from blast furnace slag, which has found application at a considerable number of blast furnaces in Germany, has been extended to the making of pipes by a relatively simple and inexpensive process. These pipes, upon testing, have shown to have satisfactory strength. In the making of this pipe, two concentric former tubes or molds of sheet iron are used, and ground slag and slag sand are forced in alternating layers into the annular space between the two tubes. After a while the mixture acquires sufficient hardness to allow the tubes to be withdrawn, after which the pipes are passed into a kiln, where they are subjected to gases drawn from the blast furnace which contain the carbon dioxide necessary to combine with a lime in the slag and thereby harden the pipes. This treatment lasts for forty-eight hours, after which the pipes are said to be sufficiently hard for use. The pipes are waterproofed by providing them with an inner cement lining. The greatest difficulty met with is that the pipes are very fragile before being treated with the gas and are easily broken when the sheet-iron mold is removed.

CALORIE

The metric unit of quantity of heat, also known as the "French thermal unit," the *kilogram calorie*, is the quantity of heat required to raise the temperature of one kilogram of pure water one degree C. One kilogram calorie = 3.968 British thermal units. One British thermal unit = 0.252 calorie. The British thermal unit (B.T.U.) is the quantity of heat required to raise the temperature of one pound of pure water one degree F.

ALUMINUM ALLOYS

While aluminum is valuable for many light-weight machine parts, it is soft and lacking in tensile strength and rigidity for many purposes. In order to increase the strength, and at the same time retain the valuable property of lightness, copper, manganese, iron, and nickel have been alloyed with aluminum in various proportions. By adding from 2 to 8 per cent of any of these metals, an alloy is obtained having a strength and hardness far superior to that of aluminum. Plates and bars made from these alloys have ultimate tensile strengths varying from 40,000 to 50,000 pounds per square inch with an elastic limit of from 55 to 60 per cent of the ultimate tensile strength, an elongation of 20 per cent in 2 inches, and a reduction of area of 25 per cent. As the percentage of the heavier metals that is added to the aluminum is small, the specific gravity can be kept well below 3. In fact, most of these alloys have a specific gravity of from 2.8 to 2.85. In castings, the percentage of alloying metal that must be added is greater than in plates and bars. The ultimate tensile strength of aluminum alloy castings containing zinc, iron, manganese, or copper varies from 20,000 to 25,000 pounds per square inch. If tin is added to the alloy, the shrinkage is reduced, and certain aluminum-tin alloys have less shrinkage than cast iron. There are a number of aluminum alloys that are known by specific trade names.

ABSOLUTE AND GAGE PRESSURE

The pressure of air, gases, or fluids is generally measured either in absolute pressure or in gage pressure. When measured in absolute pressure, the pressure of the atmosphere is included; the gage pressure is the pressure above that of the atmosphere. As the pressure of air at sea level is 14.7 pounds per square inch, absolute pressure may be transformed into gage pressure by simply subtracting 14.7 from the absolute pressure. For ordinary conditions, such as the pressure in air compressors, steam boilers, etc., the results obtained by used the value 15, instead of 14.7, are satisfactory. The steam pressure gage of a boiler measures gage pressure.

SILVER FINISH ON BRASS

A method of silvering that is applicable to such work as gage or clock dials, etc., consists of grinding together in a mortar 1 ounce of very dry chloride of silver; 2 ounces of cream of tartar; and 3 ounces of common salt. Then add enough water to make it of the desired consistency and rub it on the work with a soft cloth. This will give brass or bronze surfaces a dead-white thin silver coating, but it will tarnish and wear if not given a coat of lacquer. The ordinary silver lacquers that can be applied cold are the best. The mixture, as it leaves the mortar before adding the water, can be kept a long time if put in very dark-colored bottles, but, if left where it will be attacked by light, it will decompose.

EFFICIENCY OF A MACHINE

The efficiency of a machine is the ratio of the power delivered by the machine to the power received by it. For example, the efficiency of an electric motor is the ratio between the power delivered by the motor to the machinery which it drives, and the power it receives from the generator. Assume, for example, that a motor receives 50 kilowatts from the generator, but that the output of the motor is only 47 kilowatts. Then, the efficiency of the motor is $47 \div 50 = 94$ per cent. The efficiency of a machine tool is the ratio of the power consumed at the cutting tool to the power delivered by the driving belt. The efficiency of gearing is the ratio between the power obtained from the driven shaft to the power used by the driving shaft. Generally speaking, the efficiency of any machine or mechanism is the ratio of the "output" of power to the "input," that is, the power required to drive the mechanism. The percentage of power representing the difference between the "input" and "output," has been dissipated through frictional and other mechanical losses.

FIREBRICK PROPERTIES

Brick intended for use in furnaces, flues, and cupolas, where the brickwork is subjected to very high temperatures, is generally known as "firebrick." There are several classes of firebrick, such as fireclay brick, silica brick, bauxite brick, chrome brick, and magnesia brick. Ordinary firebricks are made from fireclay; that is, clays which will stand a high temperature without fusion, excessive shrinkage, or warping. There is no fixed standard of refractoriness for fireclay, but, as a general rule, no clay is classed as a fireclay that fuses below 2900 degrees F. Fireclays vary in composition, but they all contain high percentages of alumina and silica, and only small percentages of such constituents as oxide of iron, magnesia, lime, soda, and potash. A great number of different kinds of firebrick are manufactured to meet the various conditions to which firebricks are subjected. Different classes of bricks are required to withstand different temperatures, as well as the corrosive action of gases, the chemical action of furnace charges, etc. The most common firebrick will melt at a temperature ranging from 2830 to 3140 degrees F.; bauxite brick, from 2950 to 3245 degrees F.; silica brick, from 3090 to 3100 degrees F.; chromite brick, at 3720 degrees F.; and magnesia brick, at 4950 degrees F.

STRENGTH OF CONCRETE

The compressive strength of concrete which, after having been mixed and laid, has set twenty-eight days, varies from 1000 to 3300 pounds per square inch, according to the mixture used. If made in the proportion 1:3:6 (one part cement, three parts sand, and six parts stone or gravel, by volume), using soft limestone and sandstone, a compressive strength of only 1000 pounds per square inch may be expected, whereas a mixture of 1:1:2, made with soft limestone and sandstone, will have a strength of 2200 pounds per square inch. A mixture of 1:3:6, made from granite or trap rock, will have a compressive strength of 1400 pounds per square inch, while a mixture of 1:1:2, made from granite or trap rock, will have a strength of 3300 pounds per square inch. Other mixtures will have values between those given. Concrete may be mixed with cinders, but, in this case, very inferior strength is obtained; the richest mixtures will give a strength of only about 800 pounds per square inch.

MICA

There are two industrial varieties of mica. One is "muscovite" (commercially known as rum, ruby, smoked, or green, according to its color) and the other "phlogopite" (amber). Only muscovite is mined on an extensive scale in the United States. Phlogopite comes from Canada and India, large quantities being imported into the United States. The chief mines in the United States are in North Carolina. The most extensive application of mica is for electrical purposes, because it is one of the best insulators available. The fact that it is able to withstand high temperatures also makes it valuable as an insulating material for electrical machinery. The laminas of mica are generally separated and sorted into various grades of purity, and are then cemented together to form plate or flexible reconstructed mica of any required thickness or purity. Mica is extremely complex and variable in composition. It generally consists of an anhydrous silicate of aluminum together with potash or sodium. Mica is characterized by a very easy cleavage in a single direction, and by a high degree of flexibility, elasticity, and toughness.

CHEMICAL EQUIVALENTS

Owing to the difficulty of determining atomic weights, some chemists have advocated the use of "chemical equivalents." The *equivalent* of an element is the relative weight of the element that combines with one part, by weight, of hydrogen. For example, 8 parts of oxygen, 35.4 parts of chlorine, 80 parts of bromine, and 16 parts of sulphur combine, respectively, with 1 part, by weight, of hydrogen; therefore, 8, 35.4, 80, and 16 are said to be the equivalents of these elements. However, many elements do not combine with hydrogen, and some combine with it in more than one proportion, so that the difficulty of determining the equivalent is as great as the difficulty of determining the atomic weight.

FUSION

The term "fusion" applies to the melting of a solid body, or to the changing of the state of a body from the solid to the liquid condition. It has been established, beyond doubt, that all substances can be transformed into a solid state at some temperature, but, in the case of gases, the temperature must be exceedingly low. It has also been established that all solid substances can be fused or melted and transformed into the liquid state, provided the temperature is high enough. Of the chemical elements, it appears that carbon will stand the highest degree of heat without melting. When changing from the solid to the liquid state, a certain amount of heat is used to accomplish this change. This heat does not raise the temperature of the body and is called the *latent heat of fusion*. This heat is applied to the body at the melting point and is absorbed by the body, although its temperature remains nearly stationary during the whole operation of melting. The latent heat of fusion varies for different substances.

PHONO-ELECTRIC WIRE

Phono-electric wide is a copper alloy wire which is intended primarily for railroad electrification and trolley work. This alloy may be produced in rod, sheet, or tube form; it is forgeable either hot or cold and can be cut much more readily than copper. When cold-drawn it has a tensile strength fully 50 per cent higher than hard-drawn copper and requires a much higher temperature to affect it adversely.

DRILL POINT ANGLE

As the angle between the cutting edges of a drill is decreased, the pressure required for feeding the drill downward through the metal, becomes less, but the length of each cutting edge is increased, with the result that more power is required to turn the drill. An included angle of 118 degrees (59 degrees between the cutting edge and axis) is believed by some to equalize the thrust and torsion to the best advantage, while others advocate more acute angles. An included angle at the point of 118 degrees and a clearance angle of 12 degrees insures, however, satisfactory results under ordinary conditions, when the grinding is done properly.

COKING COAL

Coke is the fuel commonly used in blast furnaces, and its purity, strength to resist crushing excessively under the blast furnace load, and porosity to permit free circulation of the gases, are important qualities which depend upon the kind of coal used in making the coke. The difference between coking and non-coking bituminous coals has been explained as follows: If the tars of the coal fuse and run at a temperature lower than that at which they volatilize or are driven off as a gas, then the coal may be said to be a coking coal. In this event, the freed tars permeating the fuel bed induce the formation of coke masses by closure of fuel particles and exclusion of air. Conversely, if the tars of the coal are of such composition that they volatilize and are driven off as a gas before they fuse and run through the fuel bed, the coal is then said to be a non-coking or a free-burning coal.

ATOMIC WEIGHTS

Atoms are too small to have their absolute weights determined; therefore, hydrogen, being the lightest known element, was first taken as a unit, and the atomic weights of all other elements were compared with this. It was supposed that, when the atomic weight of hydrogen was taken as the unit, the atomic weight of oxygen was 16, so that atomic weights, expressed on the basis of the hydrogen atomic weight being equal to 1, would also compare directly with the atomic weight of oxygen, expressed as 16. Later investigations have shown, however, that this ratio between the atomic weights of oxygen and hydrogen is 15.88 to 1. The leading chemical societies of the world, however, decided to retain the value of the atomic weight of oxygen as 16, and the atomic weights based on this standard are known as "international atomic weights." It has been found that the specific heat of an element multiplied by its atomic weight is a constant closely approximating the value 6.25. Upon this fact a method of determining atomic weight has been based, as the atomic weight may be found approximately by dividing 6.25 by the specific heat.

RED LEAD

Red lead is a bright red pigment made either by oxidizing litharge in furnaces or by heating it with sodium nitrate in iron pots. The color varies somewhat according to the conditions of manufacture and other details. It is widely used for the protection of iron, and is considered to be one of the best pigments known. It is generally mixed with oil, when required for use, in the proportion of 30 pounds of pigment to a gallon of oil. It exerts such a drying action on the oil that no other drier is necessary. Sulphurous gases tend to turn it brown, and it is often mixed with certain inert materials.

What Our Readers Think

on Subjects of General Interest in the Mechanical Field

THE RAILROADS NEED MACHINE TOOLS

Having had considerable opportunity of studying machine tool equipment in railroad shops, I believe that one of the most promising fields for the machine tool builder at the present time should be the locomotive shops of the country. Their need for improved machinery is undisputed. The reason that they have not bought in the past has generally been that they could not afford to do so. Now the railroads are in a fairly good financial position, their credit is good, and their securities sell well. They can plan ahead safely for several years at least, and there is no reason why they should not take advantage of the present conditions to put their machine shops on such a basis that repairs can be made effectively and economically. Railroad rates and fares are no longer below the average level of prices, as compared with pre-war conditions. On the contrary, in many instances they are somewhat higher, and that being the case, the railroads will doubtless be able to put their house in order within the next two or three years. FOREMAN

* * *

SHOP MAN VERSUS PURCHASING AGENT

Some time ago a writer in MACHINERY stated that as a machinery salesman he had for many years used the slogan, "It costs more to do without good equipment than to buy it." The writer's experience over a period of years in machine shop operation verifies this statement; and yet it is very difficult for the shop man to obtain the kind of equipment that he wants, because the purchasing agent is inclined to consider the price of the equipment only, irrespective of the work or lasting qualities of the machines.

Purchasing agents in large concerns are so much in the habit of buying materials for temporary use, to specifications, rather than machinery for capital investment, that they do not seem to discriminate between the two classes of purchases. In buying screw stock, it is all right to buy from the mill that will sell for a quarter of a cent less a pound, but in the case of machine tools, it is the quality and increased productive capacity of the machine that counts far more than the initial cost. Furthermore, the sooner a good machine can be put at work producing profits, the better for the buyer.

A man who would never think of buying a $22.50 overcoat, because he knows that it cannot have the quality he desires, will hunt around to find out which is the cheapest machine tool of a given type on the market and then buy that machine. Why does his experience serve him in the one instance and not in the other? S. M.

* * *

SERVICE IDEA RUNNING TO EXTREMES

Business, like mankind at large, often turns normal activities and developments into fads. The ideas of scientific management that date back more than half a century, and that finally obtained their chief exponent in Fred W. Taylor, for a while ran riot and became very much of a fad. Yet, the underlying idea is not only sound, but one upon which every successful business must be built if it is to endure. The present fad is "service." It is perfectly normal that every business should render assistance and service to its customers in connection with the product it sells, and service is a legitimate claim upon the seller; but in some cases service is being rendered in fields entirely foreign to that of the business relation between the buyer and seller.

Thus, for example, one of the large life insurance companies has instituted a policy holders' service bureau, and in a recent publication announces the fact that service has recently been rendered to some of its group policy holders relating to such subjects as an accounting procedure for checking the deliveries of the drivers in a bakery business, information relating to the growth of the paper industry in certain parts of the United States, suggestions for staging a play in a Pennsylvania department store, and other similar "services." It is somewhat difficult to connect the service that should normally be rendered by a life insurance company with those mentioned.

What has this to do with the machine-building industry? Simply this, that the service idea "is going to grow," and it is likely for a time to exceed its natural and normal limits of development. It is therefore well for all service departments to watch their step and to carefully consider whether the service rendered is one that is a legitimate part of the business or an abnormal growth that has no direct connection with the business. In the latter case it will become a wasteful business practice that will cause an unnecessary drain upon the resources of any industry that fails to recognize the proper limitations of its relation with its customers—and, furthermore, the customer will pay. E. V.

* * *

MAKE CATALOGUES READABLE

The main object of a catalogue is to attract the attention of a prospective customer. Hence, it should be typographically attractive, easy to handle, and should present its case in a simple and direct manner. These are fundamentals that most people who prepare advertising matter thoroughly understand. There is one point relating to readable catalogues and circular matter, however, that does not seem to be as well understood as it ought to be. Some very expensively gotten up advertising literature is difficult to read because of the use of too long a line and too small type.

The length of the line that makes reading easy depends upon the size of the type in which it is set. The smaller the type, the shorter should be the line; but even when quite large type-sizes are used, the length of the line should be moderate, because it greatly facilitates reading if the eye does not need to travel from the right to the left in passing from line to line. A line that is not too long for the whole length to be compassed by the eye, so that the eye simply has to move gradually downward as the reading proceeds, is the best length of line for quick and easy reading, and the attention of the reader can be given entirely to the matter contained on the printed page.

The writer recently saw some matter that was prepared to explain the Dawes plan. It was an excellently prepared statement of the fundamentals involved in the German settlement, but much of the information was printed in small type in a line 9 inches long, entirely across the sheet, which was almost impossible to read without great effort.

Another fault that I frequently find with advertising matter is that the advertising writer attempts to create interest on the part of the reader by withholding from him a plain, matter-of-fact statement as to what it is all about, until the last few lines or paragraphs are reached. Many a circular goes into the waste basket for that very reason, because busy men cannot afford to spend their time reading several paragraphs—sometimes pages—of non-essentials before they reach something that really interests them.

ADVERTISING READER

Interchangeable Broaches for Keyways

By CHARLES G. PFEFFER

STANDARD keyway broaches as made by the broach manufacturers are so designed that they are interchangeable over a definite range of work in so far as cutting different sized keyways in work of the same size bore is concerned. Articles have been published in MACHINERY containing formulas for calculating the dimensions of keyway broaching bushings when the depth of the keyway is measured at the edge. To the writer's knowledge, however, no formulas have been evolved for use in designing a cutter for broaching keyways of one size in bores of different diameters. In the present article a method of designing cutters that will permit the broaching of one size keyway in bores of different size with one cutter is described. The accompanying tables give dimensions for a set of cutters for broaching keyways in holes from 1 inch to 7 inches in diameter and with twelve widths of keyways ranging from ⅛ to 1 inch in width.

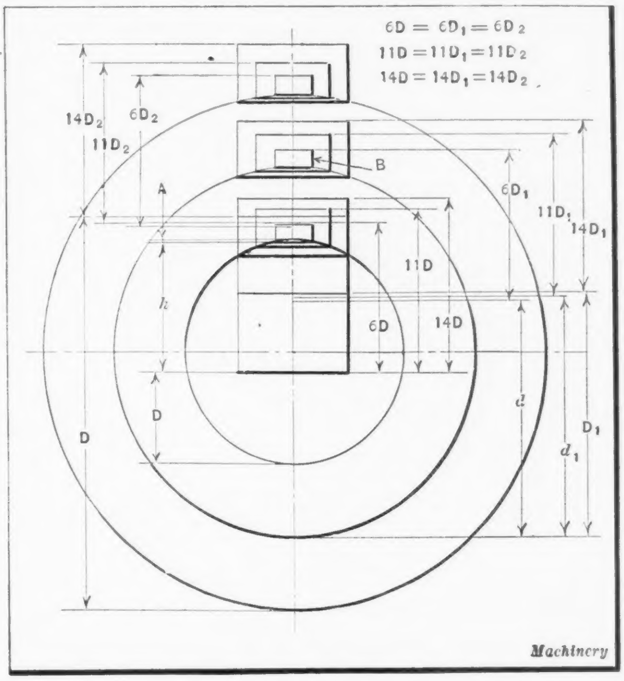
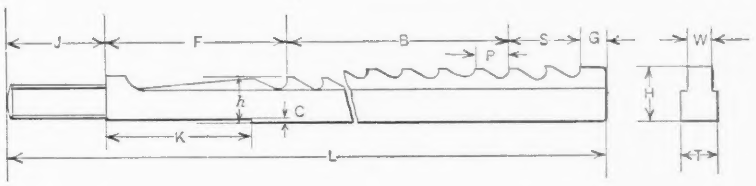


Fig. 1. Diagram showing Positions of Cutters in Bushings of Different Sizes

It is possible to use a keyway cutter of one width for broaching keyways in a wide range of bores and still keep within the usual limits of accuracy. The standard practice in most manufacturing plants is to place a tolerance on keyway dimensions of minus 0.0 and plus 0.020 inch. It is, of course, necessary to establish limits for the minimum and maximum diameters of the bore or hole in which the keyway is to be broached. These limits are of such a range that they include all average sizes, and in the cases considered in this article were taken from actual practice. The conditions with which the broaching operation must conform are as follows: The depth of the keyway must be held within the specified tolerance; the starting tooth of the cutter must be low enough to enter the work without taking a cut in order to prevent overloading of the following teeth; the broach shank must be long enough to give the tapered section sufficient slope to prevent interference between the broach teeth and the work when the work is being put in place; and the minimum or smallest bore in which a cutter or broach can be used is determined by the deepest slot that can be cut in the bushing.

In Table 1 are given the necessary dimensions for the keyway cutters or broaches, the proportions being based on those of standard make. Tables 2 and 3 give the dimensions for cutting the slot in the bushing to the correct depth. Referring to Table 1, the letter that comprises part of the broach number or symbol indicates to what degree the cutters are interchangeable; for instance, all the cutters containing D in their designating symbol or number, as shown in the first column of the table, can be used interchangeably in the same bushing.

TABLE 1. DIMENSIONS OF KEYWAY CUTTERS OR BROACHES



Broach Number	Width of Key W	Width of Slot T	Height of Last Tooth H	Height of First Tooth h	Depth of Undercut C	F	Length of Threaded Part J	Total Length L	Pitch P	Number of Teeth in Tapered Section B	Number of Cuts
6D	1/8	½	0.839	0.755	1/64	6⅞	1¾	37	0.538	48	1
8D	3/16	½	0.865	0.749	1/64	7⅜	1¾	41	0.592	49	1
11D	1/4	½	0.891	0.745	1/64	7⅜	1¾	41	0.592	50	1
14D	5/16	½	0.916	0.740	1/64	8⅜	1¾	52½	0.74	53	1
17D	3/8	½	0.938	0.740	1/64	8⅜	1¾	54	0.74	55	1
21G	7/16	⅝	1.371	1.245	1/32	10⅜	2	53	0.825	45	2
24G	1/2	⅝	1.386	1.242	1/32	10⅞	2	54⅜	0.84	45	2
27G	9/16	⅝	1.391	1.239	1/32	11⅜	2	55	0.9	43	2
31J	5/8	1	1.675	1.49	3/64	12⅜	2	56	1.00	39	2
33J	3/4	1	1.688	1.49	3/64	12⅜	2	56	1.00	39	2
36K	7/8	1¼	1.911	1.74	1/16	14⅜	2	56	1.125	32	3
38K	1	1¼	1.917	1.74	1/16	14⅜	2	56	1.125	30	3

Machinery

The dimensions for the bushings given in Tables 2 and 3 were calculated for the No. 3B broaching machine made by the J. N. Lapointe Co., New London, Conn. Dimension N, Fig. 2, was taken as 3 inches, allowing ⅜ inch for the flange and ⅝ inch for the clearance between the end of the broach and the bushing. The smaller bushings are made of steel and the larger ones of cast iron, a core being employed to reduce the weight of the casting. For bores over 4 inches in diameter, it is necessary that the cutters be offset, owing to the limited travel of the draw-head. The dimension P of the bushing, as indicated in the diagram at the head of Table 2, must be made to fit the bushing plate or the faceplate of the machine. The minimum length of the work need not be considered, as the work is supported by the bushing and for this reason it cannot drop down between the teeth of the broach.

Calculating Depth of Slot in Bushing

Fig. 1 shows graphically the positions of the cutter when broaching keyways in bores of various sizes. When the bore remains constant and the width of the keyway changes, it is obvious that the height of the arc A also changes. This is clearly shown by the table on page 499 of MACHINERY'S HANDBOOK. When the bore is changed and the width of the keyway remains the same, the height of the arc A again changes. A separate bushing is provided for each sized bore, and the dimension D for each bushing is fixed. The height and width of each broach are also fixed so that the height of arc A varies, for which compensation must be made. In the illustrations,

D = distance from outside of bushing to bottom of slot (see illustration at top of Table 2);

A = height of arc =

$$R - \sqrt{R^2 - \left(\frac{W}{2}\right)^2}$$

in which R = radius of shaft, and W = width of keyway; (The height of the arc may, in most cases, be found in the table in MACHINERY'S HANDBOOK previously referred to.)

h = height of starting or first tooth on broach; and

$D + h$ = diameter of bore minus height of arc A.

For a ⅛-inch keyway and a 1-inch bore we have:

$D + h = 1.000 - 0.004 = 0.996$ inch

and for a ⅛-inch keyway and a 2-inch bore we have

$D + h = 2.000 - 0.002 = 1.998$ inches

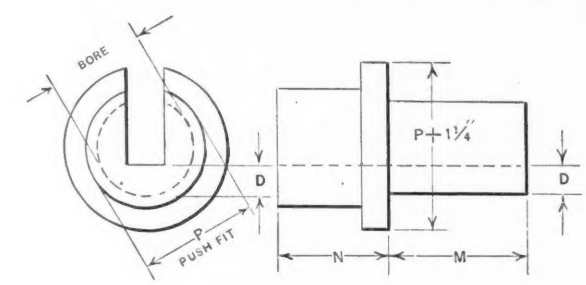
Thus it is evident that the value of $D + h$ for a bore of 2 inches is greater than for a 1-inch bore.

When but one size of keyway is considered, it is possible to arrange the height of the slots in the different sized bushings so that each keyway will have the correct depth. Now as the bore increases, the change in the height of the arc becomes proportionately greater.

In establishing the height D of the slot in the bushing for the smallest bore, it is evident from Fig. 1 that if D is figured from the smallest broach, D_1 will not be correct for broaching the small keyway at B. Instead the height D should be equal to d in order to have the cutter height $6D_1$ equal the required height $6D$. Moving the dimension $11D$ and $14D$ down to meet the upper limit of dimension d would result in making the keyways too shallow. If the slot begins at the upper limit of D_1 the dimension $6D_1$ will be too deep and $14D_1$ too shallow. If the positions of dimensions $6D_1$ and $11D_1$ are moved up to the starting point of dimension $14D_1$, the dimension $14D_1$ will be correct, but dimensions $6D_1$ and $11D_1$ will be too deep.

It follows, therefore, that when the depth of the slot is calculated from the widest keyway cutter or broach of one range of sizes, the widest keyway will be of the correct depth, while smaller keyways will have a clearance at the top and none of the keyways will be less than the full depth. This is the condition required by the limits, provided the tolerances are not exceeded.

TABLE 2. DIMENSIONS OF BUSHINGS FOR BROACHING



Width of Keys ⅛ to ⅜ Inch, Inclusive

Bore	D	Bore	D	Bore	D	Bore	D
1	0.223	1 7/8	1.116	2 3/4	1.997	3 5/8	2.875
1 1/16	0.288	1 15/16	1.179	2 13/16	2.059	3 11/16	2.937
1 1/8	0.353	2	1.241	2 7/8	2.122	3 3/4	3.000
1 3/16	0.417	2 1/16	1.305	2 15/16	2.185	3 13/16	3.062
1 1/4	0.481	2 1/8	1.368	3	2.248	3 7/8	3.125
1 5/16	0.544	2 3/16	1.431	3 1/16	2.310	3 15/16	3.185
1 3/8	0.608	2 1/4	1.494	3 1/8	2.374	4	3.251
1 7/16	0.672	2 5/16	1.556	3 3/16	2.436	4 1/8	3.366
1 1/2	0.736	2 3/8	1.62	3 1/4	2.499	4 1/4	3.501
1 9/16	0.799	2 7/16	1.682	3 5/16	2.561	4 3/8	3.627
1 5/8	0.863	2 1/2	1.745	3 3/8	2.624	4 1/2	3.752
1 11/16	0.926	2 9/16	1.808	3 7/16	2.686	4 5/8	3.877
1 3/4	0.989	2 5/8	1.871	3 1/2	2.749	4 3/4	4.002
1 13/16	1.052	2 11/16	1.933	3 9/16	2.811	.....	.....

Width of Keys 7/16 to 9/16 Inch, Inclusive

Bore	D	Bore	D	Bore	D	Bore	D
1 1/2	0.206	2 9/16	1.290	3 5/8	2.364	5 3/8	4.220
1 9/16	0.270	2 5/8	1.354	3 11/16	2.426	5 1/2	4.245
1 5/8	0.335	2 11/16	1.417	3 3/4	2.479	5 5/8	4.371
1 11/16	0.399	2 3/4	1.480	3 13/16	2.551	5 3/4	4.497
1 3/4	0.463	2 13/16	1.544	3 7/8	2.614	5 7/8	4.622
1 13/16	0.527	2 7/8	1.643	3 15/16	2.677	6	4.747
1 7/8	0.592	2 15/16	1.670	4	2.740	6 1/8	4.872
1 15/16	0.655	3	1.733	4 1/8	2.865	6 1/4	4.898
2	0.720	3 1/16	1.795	4 1/4	2.992	6 3/8	5.123
2 1/16	0.783	3 1/8	1.858	4 3/8	3.118	6 1/2	5.248
2 1/8	0.847	3 3/16	1.922	4 1/2	3.253	6 5/8	5.373
2 3/16	0.911	3 1/4	1.995	4 5/8	3.368	6 3/4	5.498
2 1/4	0.976	3 5/16	2.047	4 3/4	3.493	6 7/8	5.624
2 5/16	1.038	3 3/8	2.112	4 7/8	3.618	7	5.749
2 3/8	1.101	3 7/16	2.174	5	3.744	.....	.....
2 7/16	1.165	3 1/2	2.237	5 1/8	3.870	.....	.....
2 1/2	1.228	3 9/16	2.319	5 1/4	3.995	.....	.....

Machinery

In calculating the height of the finishing tooth, let

H = height of last or finishing tooth, as indicated in Fig. 2;

$\frac{W}{2}$ = one-half width of keyway or depth of cut; and

X = clearance at top of keyway.

Then

$$D = \text{diameter of bore} + \frac{W}{2} + X - (A + H)$$

TABLE 3. DIMENSIONS OF BUSHINGS FOR BROACHING—(Continued)

Width of Keys 5/8 and 3/4 Inch

Bore	D	Bore	D	Bore	D	Bore	D
2 1/4	0.699	3 1/8	1.59	4	2.475	5 3/4	4.235
2 5/16	0.761	3 3/16	1.652	4 1/8	2.560	5 7/8	4.360
2 3/8	0.825	3 1/4	1.716	4 1/4	2.726	6	4.487
2 7/16	0.877	3 5/16	1.776	4 3/8	2.852	6 1/8	4.612
2 1/2	0.952	3 3/8	1.841	4 1/2	2.778	6 1/4	4.737
2 9/16	1.016	3 7/16	1.904	4 5/8	3.105	6 3/8	4.873
2 5/8	1.080	3 1/2	1.969	4 3/4	3.230	6 1/2	5.113
2 11/16	1.142	3 9/16	2.032	4 7/8	3.356	6 5/8	5.223
2 3/4	1.208	3 5/8	2.095	5	3.481	6 3/4	5.354
2 13/16	1.271	3 11/16	2.158	5 1/8	3.606	6 7/8	5.463
2 7/8	1.334	3 3/4	2.221	5 1/4	3.732	7	5.490
2 15/16	1.399	3 13/16	2.284	5 3/8	3.858	.....	.....
3	1.462	3 7/8	2.348	5 1/2	3.984	.....	.....
3 1/16	1.524	3 15/16	2.410	5 5/8	4.110	.....	.....

Width of Keys 7/8 and 1 Inch

Bore	D	Bore	D	Bore	D	Bore	D
2 1/2	0.656	3 5/16	1.494	4 1/4	2.449	5 7/8	4.092
2 9/16	0.720	3 3/8	1.557	4 3/8	2.576	6	4.218
2 5/8	0.785	3 7/16	1.622	4 1/2	2.714	6 1/8	4.344
2 11/16	0.849	3 1/2	1.687	4 5/8	2.831	6 1/4	4.469
2 3/4	0.916	3 9/16	1.750	4 3/4	2.957	6 3/8	4.595
2 13/16	0.981	3 5/8	1.823	4 7/8	3.083	6 1/2	4.721
2 7/8	1.046	3 11/16	1.878	5	3.209	6 5/8	4.847
2 15/16	1.111	3 3/4	1.941	5 1/8	3.336	6 3/4	4.974
3	1.174	3 13/16	2.004	5 1/4	3.461	6 7/8	5.00
3 1/16	1.237	3 7/8	2.068	5 3/8	3.588	7	5.224
3 1/8	1.303	3 15/16	2.131	5 1/2	3.714	.....	.....
3 3/16	1.366	4	2.196	5 5/8	3.840	.....	.....
3 1/4	1.431	4 1/8	2.322	5 3/4	3.967	.....	.....

DIMENSION M FOR DIFFERENT BORES (See illustration in Table 2)

For Keys from 1/8 to 3/8 Inch Wide, Inclusive

Bore	M	Bore	M	Bore	M
1–2 1/8	3 1/2	2 3/16–3 1/4	4	3 5/16–4 3/4	5

For Keys from 7/16 to 9/16 Inch Wide, Inclusive

Bore	M	Bore	M	Bore	M
1 1/2–5	7	5 1/8–6	7 1/2	6 1/8–7	8

For Keys from 5/8 to 3/4 Inch Wide, Inclusive

Bore	M	Bore	M	Bore	M
2 1/4–7	9	....	....	....	....

For Keys from 7/8 to 1 Inch Wide, Inclusive

Bore	M	Bore	M	Bore	M
2 1/2–7	11	....	....	....	....

Machinery

Using a 17*D* broach for cutting a 3/8-inch keyway in the smallest bore, which in this case is 1 inch, we have:

$D = 1.000 + 0.1875 + 0.010 - (0.037 + 0.938) = 0.2225$

With this height established, the heights of the other broaches can readily be obtained. For a 3/8-inch keyway in a bore 2 inches in diameter, we have:

$D = 2.000 + 0.1875 + 0.010 - (0.018 + 0.938) = 1.241$ inches

For a 1/8-inch keyway and a 2-inch bore we have

$D = 2.000 + 0.0625 + 0.003 - (0.002 + 0.839) = 1.225$

Thus, 0.002 is added to *D* in the case of the keyway having a width of 1/8 inch to allow for the change in the height of the arc, while 0.018 is added to *D* in the case of the keyway having a width of 3/8 inch. As the distance *D* in the bushing is established from the keyway having the greatest width, it follows that the excess clearance at the top of the tooth is the result of the change in the position or location of the arcs. When this clearance brings the location of the finishing teeth of the broach up to the maximum height set by the tolerance, the point that gives the maximum diameter of the hole or bore is established.

Now let X_1 = accumulated clearance at top of keyway. Then

$$X_1 = D + H - \left(\text{diameter of bore} + \frac{W}{2} + X - A\right)$$

Now for a bore 2 inches in diameter we have:

$$X_1 = 1.241 + 0.839 - (2.000 + 0.0625 + 0.003 - 0.002) = 0.01765$$

For a 1/8-inch keyway, the height of arc *A* for a 1-inch bore minus the height of arc *A* for a 2-inch bore = 0.004 — 0.002 = 0.002 inch. Now for a 3/8-inch keyway, we have the height of arc *A* for a 1-inch bore minus the height of arc *A* for a 2-inch bore = 0.037 — 0.018 = 0.019 inch. Thus

$$0.019 - 0.002 = 0.017$$

which is equivalent to the accumulated clearance at the top of the 1/8-inch keyway.

The height of the starting tooth is changed to conform with the changes in the dimension *D*, being raised an amount equal to the difference in the change of the two arcs *A*.

Designing the Keyway Cutters

It follows that if the height of the starting tooth is calculated from the largest bore for each sized keyway, the clearance will become greater as the diameter of the bore is diminished. The maximum length of the work is governed by the conditions explained in connection with Fig. 2. In order to permit the work to slip on the bushing, it is necessary to bring it into a parallel plane, as shown by the dotted lines. If the sloping section of the broach should interfere with the work inside of the portion indicated by dimension 2*M*, it would cause the work to tilt so that it would be impossible to bring it into the proper position for broaching the keyway. As shown in Fig. 2, an under-cut C_1 is ground on the broach to permit it to drop down a sufficient amount so that the sloping section within the section 2*M* will clear the work.

The under-cut must be ahead of the first tooth so that the depth of the cut is uniform after it has once started. The depth of the under-cut C_1 must equal the distance *C*. The depth of the cut per tooth, the pitch, and the active portion of the broach are the important factors that determine the total length of the broach, which, in turn, is governed by the stroke of the machine. Too many teeth will be brought in contact with the work at the same time if the pitch or spacing of the teeth is too fine. This will reduce the chip space and cause overloading of the teeth.

Broaches as made by the manufacturers are designed to have from four to eight teeth in cutting action at the same time. Therefore, the pitch is found by dividing the length

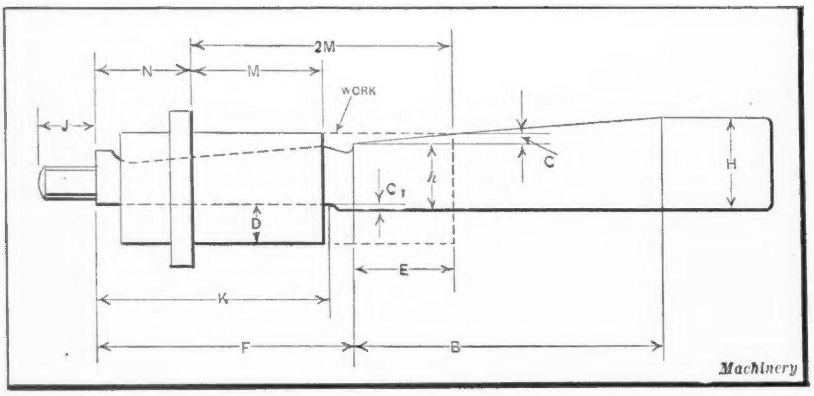


Fig. 2. Relative Positions of Cutter, Bushing, and Work

of the work by the proper number of cutting teeth. The depth of the cut per tooth is the total depth of the cut divided by the number of teeth in the active portion of the broach. The depth of the cut averages from 0.003 to 0.004 inch, being less for the smaller broaches and slightly more for the larger ones. The active portion of the broach or the length of the tapered section equals the pitch multiplied by the number of cutting teeth. To this length is usually added four straight teeth and a short pilot at the finishing end. Referring to Fig. 2 and to the illustration accompanying Table 1, we have:

N = distance from face of flange to end of ram at starting position;
M = maximum length of work;
P = pitch of teeth;
G = length of pilot;
J = length of threaded section;
B = length of tapered or cutting portion of broach; and
L = total length of broach.

Then

$$N + M + \frac{1}{8} = K \text{ and } K + \frac{1}{4} = F$$

Now

$$L = J + F + B + 4P + G$$
$$E = N + 2M - F$$

and

$$\frac{H - h}{B} = \frac{C}{E} \text{ or } C = \frac{E\,(H - h)}{B}$$

* * *

HEAT-TREATMENT NOT ALWAYS AT FAULT

By CARL M. BOHNER

Tool breakage is a common occurrence in small as well as in large plants, and is a source of annoyance, especially when it delays production and involves a considerable expense for unproductive labor. The importance of this fact will be appreciated when we stop to consider that a toolmaker often spends two or three weeks making a small die. It is only natural for the uninitiated to hold the heat-treater responsible for tool failure, as "the man at the fire" is generally supposed to be responsible for the service that the hardened tools give.

Several cases may be cited, however, to show that the heat-treatment is not always at fault. In one instance that came to the attention of the writer, several tools repeatedly failed to harden satisfactorily in oil and others cracked when quenched in water, even before they were completely cooled. An investigation revealed the fact that the trouble was due to the mixing of several brands of oil- and water-hardening tool steels in the stock-room. After the stock had been cut off and its label destroyed or detached, the identity of the bar was lost, with the result that the stock-keeper simply put the steel in the bin in which he thought it belonged. This trouble was remedied by requiring each bar of stock to be painted for its whole length with some color that would distinguish it from all other brands of steel.

Pneumatic riveting punches for repairing cracked tenon cups on steel folloes were made of oil-hardened tool steel and tempered at 900 degrees F. They were subjected to severe blows by the air hammer, and naturally all failed to withstand this treatment after a few hours service. The failure was assigned to faulty heat-treatment, but the real cause of the trouble lay in attempting to use steel that was not adapted for the use to which it was put. This is a mistake often made even by experienced toolmakers. In this case, toughness was the prime requisite, and a certain brand of 0.75 per cent carbon steel, hardened in water and tempered to 500 degrees F., stood up well under the severe service.

Accuracy in Setting up Die for Punching Operation

Inaccurate setting of a die and also the use of worn-out shearing machinery are sources of trouble, as either or a combination of both of these factors may permit the tools to strike or come in contact with each other and thus chip off their cutting edges. In one instance in which the punches and dies failed in service, the cause was assigned to incorrect tempering. An investigation showed, however, that the tools were not made with the proper amount of clearance. A good general rule to follow in designing tools of this kind is to allow a clearance of about one-sixth the thickness of the metal to be punched. For hard metals this ratio can sometimes be reduced to one-twelfth.

In one case, the trouble experienced with an intricate slot die was eliminated by providing generous fillets wherever there were sharp corners, and slightly rounding the sharp V-portion of the die and thickening the thin projecting members which were out of proportion with the main body of the die.

Care Necessary in Grinding

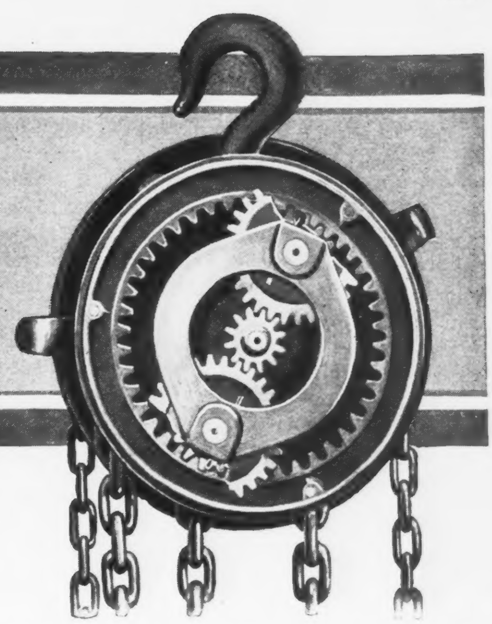
One trouble frequently encountered in machine shops is the cracking of steel caused by grinding Many failures of high-speed steel can be traced to carelessness in performing the grinding operations. The cracking of steel here referred to is caused by the local heat not being radiated fast enough, and therefore setting up local expansion while the adjacent material is comparatively cool and rigid. Hard grinding wheels can best be used on soft materials, but for high-speed steels a soft free-cutting grade should be employed in order to lessen the danger of drawing the temper at the cutting edge. However, the cut must be light and the wheel generously supplied with water. Glazed wheels have a tendency to burn the work, and for this reason all wheels should be dressed as soon as they begin to show any signs of glazing.

The splitting of twist drills through the web section is caused by dullness of the cutting edges, too heavy cuts, and insufficient clearance. Milling cutters and taps deteriorate rapidly when dull, and for this reason frequent grindings will prolong their life. Too little water and undue pressure on the grinding wheel should be avoided, as this serves to prevent the water from reaching the work at the point of contact with the wheel, so that when the tool is released the cold water chills the hot metal and causes surface cracks. The common practice of dry-grinding high-speed steel tools and then cooling them in a bucket of water should be severely condemned.

The cases referred to in this article should make it clear that faulty heat-treatment is not always the cause of failure. The failure of hardened tools on machine parts can often be prevented by taking all factors into consideration when designing the tool, and for this reason the designer should cooperate with the heat-treater. In this line of work, cooperation is the key to success.

Planetary Gearing

By FRANKLIN DeRONDE FURMAN
Professor of Mechanism and Machine Design
at Stevens Institute of Technology



Planetary Type of Automobile Transmission—Watt's Sun and Planet Wheels—Planet Wheel of Internal Type
Eighth Article

THE planetary automobile transmission illustrated diagrammatically in Fig. 34, provides three forward speeds and a reverse, and is of interest, as it shows how this number of speeds can be obtained from a single driving shaft without the changing or sliding of gears. This type of transmission was used formerly in the Cadillac car. A brief description of the gear will be given, followed by an analysis of the different actions involved. This transmission has triple planet gears on one block, and there are pairs of planet wheels on different centers. Referring to Fig. 34, A is the driving shaft and B the driving pinion keyed to it. The follower wheel C is an internal one, and E is the follower shaft. When running full speed ahead, the entire mechanism is locked together in one solid piece, as follows: The end disk F is pressed into frictional contact with the side of the drum G, which carries a pinion T_2. Thus the drive shaft A gives its angular velocity to the two pinions T and T_2. Since T is connected through gear T_6 and pin J to drum H, and since T_2 is also connected to drum H through gear T_4 and pin I, drum H will have the same angular velocity as the drive shaft. Furthermore, gear T_5 will have the same angular velocity about the drive shaft as T_4 because T_5 and T_4 are integral. Since T'_2 is geared to T_5, the drum K will have the same angular velocity as drums H and G. Finally, since T_6 is driven at two points with the same angular velocity about the shaft A (first, by pinion T, and second, by pin J which is fastened in H), T_6 cannot turn on pin J, and therefore transmits its simple revolution about A to the internal follower wheel C.

For running in intermediate gear, forward, disk F is withdrawn from drum G and this drum is held stationary by a brake-band which is tightened against its cylindrical surface. Since drum G cannot turn, the pinion T_2 which is fastened to it cannot turn; consequently when T is driven by shaft A, it drives through the gears T_6 and T_3 to T_4. The latter gear fulcrums on the teeth of T_2 which is fixed. (In the sectional view, T_6 is not shown in gear with T_3, but from the end view it will be seen that there are three sets of planet wheels T_3, T_4, and T_5, and three separate planet wheels T_6 set alternately around the circle, and that T_6 of the sectional view, therefore, meshes with a wheel similar to T_3). This gives to the wheel T_6 two separate motions, one from T and one from T_3, and the resultant of these two motions of T_6 is given to the internal follower wheel C so that it turns with 0.6 of the angular velocity of the drive shaft A.

For running in low gear, forward, drum K is held stationary, and all other drums are free. Fastened to drum K is the gear T'_2 which is therefore also stationary and which now serves as the fulcrum for the planet wheel set T_5, T_4, T_3. Since planet wheel T_3 meshes with T_6, and since T is also driving T_6, the latter wheel is subject to two separate motions, the resultant of which is given to the internal follower C which now turns with one-third the angular velocity of the driving shaft.

For running in reverse, drum H is held stationary, and all other drums are free. As pins I and J, which are fastened to drum H, are also stationary, the planet wheel set T_3, T_4, T_5 is prevented from acting on the planetary principle. Instead, these gears now act as simple fixed gear wheels and there is no planetary gear problem at all. The driving pinion T turns the gear wheel T_6 which turns the internal gear wheel C with one-third the speed of the drive shaft A, the direction of turning of wheel C being opposite to that of shaft A.

While in intermediate, low, or reverse, there will be considerable idle motion in the drums and gears that are not held stationary. This is most easily shown, perhaps, in connection with reverse running, during which time T_6 is also driving T_3 which latter causes T_4 and T_5 also to turn on the fixed pin I, thus giving a turning motion to the wheels T_2 and T'_2, respectively, and

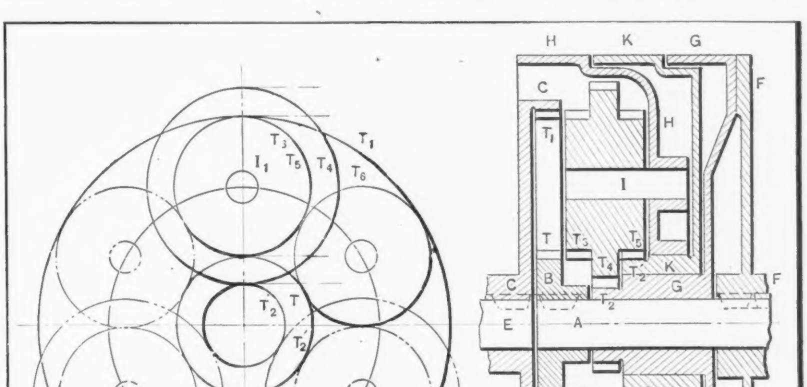


Fig. 34. Planetary Gear Mechanism providing Three Forward Speeds and One Reverse Movement—Problem 23

causing drums G and K to rotate idly in a direction opposite to that of the follower wheel C. As pointed out previously, the follower wheel will turn at one-third the speed of the driver and in the opposite direction. It may also be added that drum G will turn idly at 2 1/3 times the speed of the driver, and drum K will turn at the same speed as the driver, both in opposite directions to that of the driver. The problem of idler drum speeds for the different conditions under which the mechanism operates is one not only of academic interest, but of important practical interest in making proper allowances for inertia effects and for proper lubrication in the design of the gear. While only the idler motions for reverse running are here pointed out, there are also other idler motions when operating in intermediate and low gears. The notation follows:

N = number of turns of driver to one of follower or driven member;
N' = number of turns of follower to one of driver;
N_1 = number of turns of driver to one complete revolution of planet wheel axis;
N_2 = number of turns of follower to one complete revolution of planet wheel axis;
D = diameter of pitch circle of driver, if driver is a toothed wheel; (The driver, or the follower, may be the "train arm" and not one of the toothed wheels, according to the data of a problem.)
D_1 = diameter of pitch circle of follower, if follower is a toothed wheel;
D_2 = diameter of pitch circle of fixed wheel;
D_3, D_4, etc., = diameters of pitch circles of planetary wheels;
T = number of teeth on driver, if driver is a toothed wheel;
T_1 = number of teeth on follower, if follower is a toothed wheel;
T_2 = number of teeth on fixed wheel; and
T_3, T_4, etc., = number of teeth on planetary wheels.

Problem 23—Summarizing from the previous general description, the data for the planetary transmission mechanism (Fig. 34) in which there were three forward speeds and one reverse, are as follows, the numbers of teeth being given and all teeth being of the same pitch. $T = 30$; $T_1 = 90$ (internal); $T_2 = 18$; $T'_2 = 30$; $T_3 = 30$; $T_4 = 42$; $T_5 = 30$; and $T_6 = 30$. In high-speed gear, the entire mechanism runs as one solid piece. In intermediate speed gear, forward, T_2 is held stationary, T is the driving wheel, and T_1 is the follower. In low-speed gear, forward, T'_2 is held stationary, and T and T_1 are the driver and follower wheels, respectively, as in the intermediate gear. In reverse gear, the train arm is held stationary, the driving and follower wheels being the same as in the two preceding cases. Apply the graphical and analytical methods of solution.

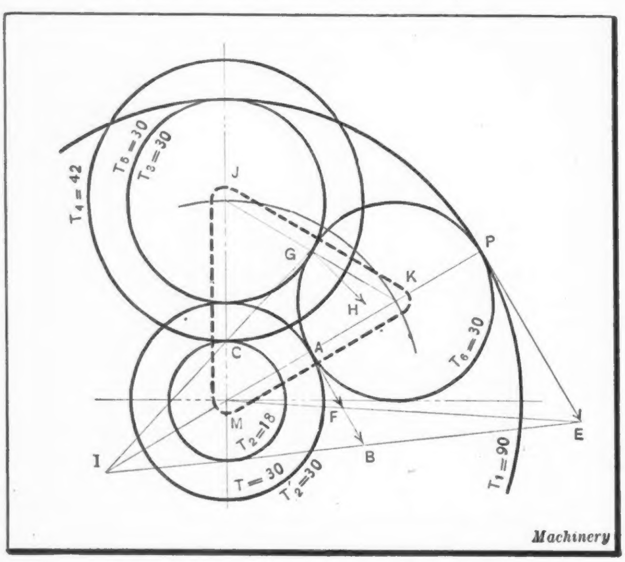


Fig. 35. Graphical Solution for Intermediate Speed of Mechanism shown in Fig. 34—Problem 23

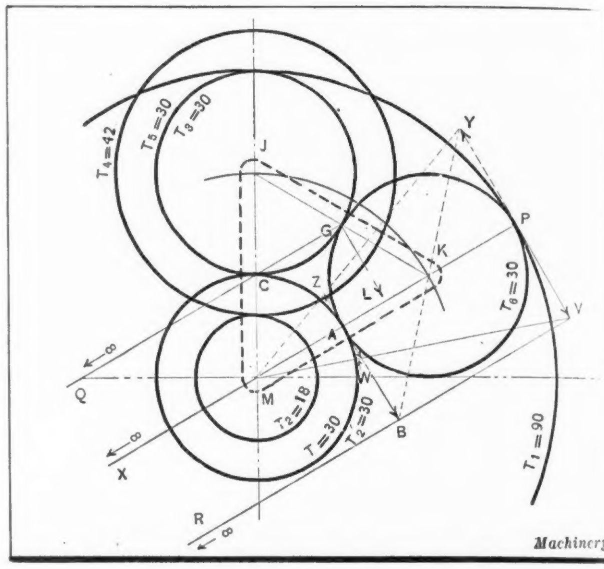


Fig. 36. Graphical Solution for Low Speed and Reverse Movement of Mechanism shown in Fig. 34

The graphical solutions for the intermediate and low speeds and for the reverse are illustrated in Figs. 35 and 36. The graphical work that might be shown for full speed forward is omitted, as it would only encumber the drawing and is not necessary to an understanding of the full-speed action which may be observed in a more analytical way in Fig. 35 by noting that in full speed the sun wheels T and T_3 are both driving with the same angular velocity as the drive shaft, and therefore the planet wheel system T_3, T_4, T_5, T_6 has two points (at A and C) having the same angular velocity about M. It follows that all points in this planet wheel system must have the same angular velocity about M under these conditions, and therefore the point P of the follower wheel T_1 has the same angular velocity as the drive shaft

Graphical Solution for Intermediate Speed—Problem 23

The graphical solution for intermediate speed is shown in Fig. 35. The peripheral velocity of the driving gear T is represented by AB, and this is also the resultant motion of the point A on the planet wheel T_6. Since T_2 is held stationary in intermediate gear, the planet wheel set T_3, T_4, T_5 must rotate about C as an instantaneous center, and therefore GH, perpendicular to CG, must be the resultant direction of motion of the point G on the triple planet wheel set and also of the point G on the planet wheel T_6.

Since the resultant directions of motion (AB and GH) of two points on the planet wheel T_6 are known, the instantaneous axis of that wheel may be found by drawing perpendiculars AI and GI to these two lines. The intersection of these two perpendiculars is the instantaneous axis of the wheel T_6, and every point in T_6 including P has an instantaneous motion of simple revolution about I. If point A on T_6 has a linear velocity AB, then point P on both T_6 and T_1 must have a linear velocity PE found by drawing the line IB and extending it to E. It is now found that PE is the peripheral velocity of the follower wheel T_1, and if this velocity is compared with the driver velocity AB at unit radius AM, the relative speeds of driver and follower wheels may be determined directly by a comparison of the lengths of the lines AB and AF. Choosing any scale, if AB should measure 12 units and AF 7 units $N = \dfrac{AB}{AF} = \dfrac{12}{7}$, or

$$N' = \frac{AF}{AB} = \frac{7}{12} = 0.6 \text{ approximately,}$$

which means that the internal follower wheel T_1 makes 0.6 of a turn while the driving wheel T makes one turn.

Analytical Solution for Intermediate Speed—Problem 23

The analytical method of solving for the relative speeds in intermediate gear is accomplished by noting first that

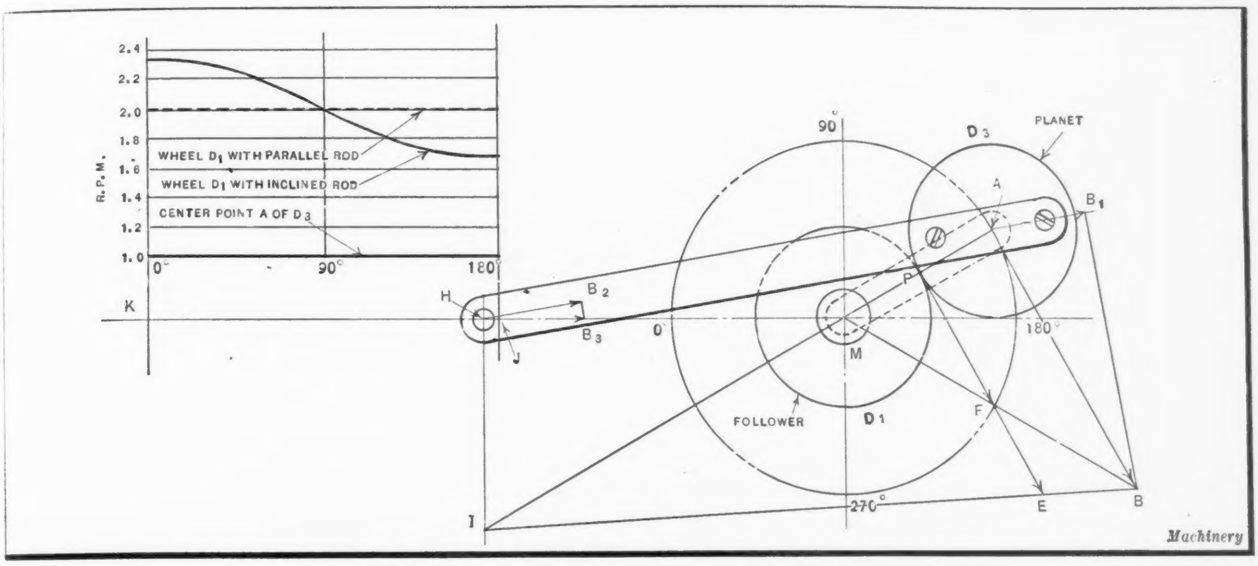


Fig. 37. Watt's Sun and Planet Wheels and Velocity Diagram

the planet wheel pins J and K, Fig. 35, are not fixed in either the driving or following member, and therefore it is necessary to find, first, the number of turns, N_1, of the driver T to one full turn of the planet wheel pins, and second, the number of turns N_2 of the follower T_1 to one full turn of the planet wheel pins, and then to divide N_2 by N_1 to obtain the rotation of the follower with respect to the driver. Keeping in mind the structural features of the mechanism and the numbers of teeth on the wheels:

$$N_1 = 1 + \frac{T_2}{T_4} \times \frac{T_3}{T_6} \times \frac{T_6}{T} = 1 + \frac{18}{42} \times \frac{30}{30} \times \frac{30}{30} = \frac{10}{7}$$

$$N_2 = 1 - \frac{T_2}{T_4} \times \frac{T_3}{T_6} \times \frac{T_6}{T_1} = 1 - \frac{18}{42} \times \frac{30}{30} \times \frac{30}{90} = \frac{6}{7}$$

$$N' = \frac{N_2}{N_1} = \frac{6}{7} \times \frac{7}{10} = 0.6$$

or, the follower wheel T_1 makes 0.6 turn while the driver T makes one turn when the mechanism is set in intermediate gear.

Graphical Solution for Low Speed—Problem 23

The graphical solution for low speed for the mechanism in Fig. 34 is shown by fine solid lines in Fig. 36. The principle involved in the solution is the same as for the intermediate gear solution previously given, although the problem in low gear in this particular mechanism is a special case and one step in the process will need amplification, especially to those not familiar with the general use of velocity diagrams. Since T is the driver, its peripheral velocity may be represented by AB as before. This is also the resultant velocity of point A on T_6. Since T'_2 is held stationary, the points C on T'_2 and T_3 are also stationary, and the point G on T_3 must, consequently, be actually turning about C in the direction GL. Inasmuch as G on T_6 is in non-sliding contact with T_3, G on T_6 must also be moving in the direction GL. Hence two resultant motions, AB and GL of T_6 are now known, and in this particular problem they are parallel, because of the equality of sizes of T'_2, T_3, and T_6. The perpendiculars AX and GQ to these two lines are therefore parallel and meet at infinity. This means that the instantaneous axis of T_6 is at infinity and that this wheel is turning on a radius of infinite length, or in other words, the wheel has a motion of rectilinear translation and every point on it is moving at the instant in the same direction and with the same velocity. Consequently P on T_6, as well as P on T_1, is moving with a velocity PV which is parallel and equal to AB. This is also found by drawing the line RBV from the infinitely remote instantaneous axis of T_6 through B to V in the same general way that the line IBE (Fig. 35) was drawn in the intermediate gear problem. In order to compare the angular velocities of T and T_1, PV is reduced to AW and $N' = \frac{AW}{AB}$.

Analytical Solution for Low Speed—Problem 23

The analytical solution for low speed is identical in method with the solution given in a preceding paragraph for the intermediate speed, and the formulas will therefore be set down directly.

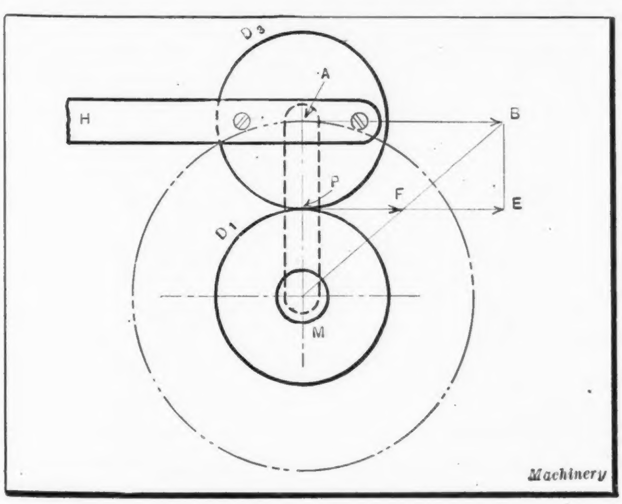


Fig. 38. Sun and Planet Wheels at 90-degree Position—Drive Rod Parallel at all Phases

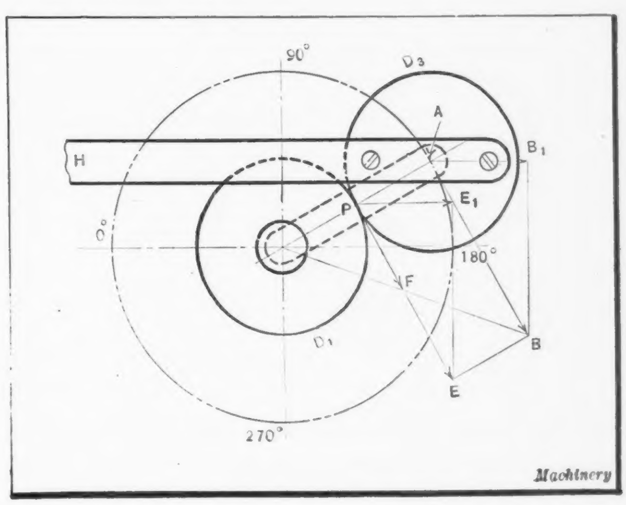


Fig. 39. Sun and Planet Wheels at Another Phase in the Cycle of Motion

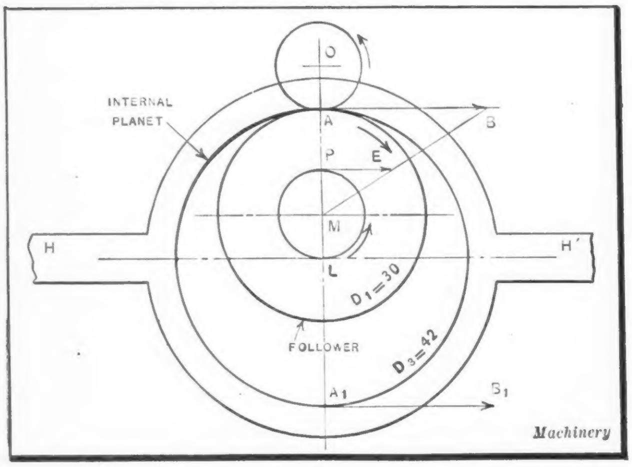


Fig. 40. Internal Type of Planet Wheel having Motion of Circular Translation—Principle of Operation Similar to Watt's Sun and Planet Wheels

$$N_1 = 1 + \frac{T'_2}{T_3} \times \frac{T_3}{T_6} \times \frac{T_6}{T} = 1 + \frac{30}{30} \times \frac{30}{30} \times \frac{30}{30} = 2$$

$$N_2 = 1 - \frac{T'_2}{T_3} \times \frac{T_3}{T_6} \times \frac{T_6}{T_1} = 1 - \frac{30}{30} \times \frac{30}{30} \times \frac{30}{90} = \frac{2}{3}$$

$$N' = \frac{N_2}{N_1} = \frac{2}{3} \times \frac{1}{2} = \frac{1}{3}$$

The result shows that the follower wheel T_1 makes one-third revolution while the driving wheel T makes one.

Graphical and Analytical Solutions for Reverse Motion—Problem 23

The graphical solution for the gear when running in reverse does not involve any planetary action at all, and hence it may be readily traced by the fine dash linework in Fig. 36. Starting with the driving velocity AB, the follower velocity PY is found by drawing the straight line BKY through the fixed center K. Reducing PY to unit radius,

$$N' = \frac{-AZ}{+AB}.$$ The minus sign is written in front of AZ because AZ is in the opposite direction to AB.

The analytical solution is made by writing a direct compound ratio of the numbers of teeth on each of the essential wheels involved.

$$N' = \frac{+T}{-T_6} \times \frac{-T_6}{-T_1} = \frac{+30}{-30} \times \frac{-30}{-90} = -\frac{1}{3}$$

The plus sign is written before T because it is assumed, to start, that the driver is turning clockwise. Then T_6 would turn counter-clockwise and so would T_1. The answer shows that the follower makes one-third turn while the driver makes one turn, and in an opposite direction.

Watt's Sun and Planet Wheels

James Watt, the distinguished Scotch engineer, patented, in 1781, in connection with his development of the steam engine, a sun and planet wheel mechanism to transmit the motion from one end of the "working beam" to the main shaft. This mechanism took the place of the now familiar crank and connecting-rod which he had also originally devised, and apparently intended to use, but an employe in his service had carried the idea to another builder who patented it and so deprived Watt of its use. Watt's planetary mechanism consisted of a sun wheel D_1, Fig. 37, keyed to the engine shaft, a planet wheel D_3 rolling on the sun wheel and held to it by a free-turning arm MA.

The remainder of the construction of the Watt mechanism consisted of a connecting-rod firmly bolted at one end, on a diametral line, to the planet wheel D_3, and pivoted at the other end H to a pin at the end of the "working beam." In the illustration here shown, the end H of the connecting-rod is made to travel in a straight-line path KJ, as it would in the case of an engine where a cross-head and guide are used, instead of in the path of a circular arc, as it would in the case of a "working beam" engine.

Inasmuch as the Watt sun and planet wheel mechanism involves a peculiar irregularity in the angular velocity of the shaft, a slightly modified mechanism in which this irregularity does not appear will be taken up first, thus affording a readier understanding of the principles involved. In Figs. 38 and 39, the same sun and planet wheels are used as in the Watt mechanism, but the drive rod HA remains parallel to itself throughout the cycle. In Fig. 38 let AB be the driving velocity at the point A. Then the point P of the planet wheel D_3 must have a parallel and equal velocity to AB because the planet wheel and drive rod are rigidly fastened together. The point P on the sun wheel D_1 must have the same velocity as the point P on D_3, and therefore $PE = AB$. The angular velocity of point A on the planet wheel D_3 about M equals $\frac{AB}{AM}$, and the angular velocity of point P on the sun wheel D_1 equals $\frac{PE}{PM}$. Therefore the angular velocity of point A on the drive rod, and on the holding arm AM, is to the angular velocity of the sun wheel D_1 as $\frac{AB}{AM} \times \frac{PM}{PE}$. This expression reduces to $\frac{1}{2}$, since $AB = PE$ as just shown, and $AM = 2\ PM$ when both the wheels are of the same size. Writing the velocity ratio in the usual way, $N = \frac{PF}{PE} = \frac{1}{2}$, or, in other words, the follower sun wheel D_1 makes two turns about the axis at M while the crankpin A in the drive rod HA makes one revolution about the same axis.

With the mechanism shown in Fig. 38, the follower sun wheel is turning exactly twice as fast as the driving crank at all phases in the cycle, as demonstrated in Fig. 39, which illustrates the mechanism in an advanced and more general position. In the latter case, the crankpin velocity AB is taken the same as it was in Fig. 38. The longitudinal component velocity of AB in Fig. 39 is AB_1, and the point P on the wheel D_3 must have the same longitudinal component velocity, as shown at PE_1, since D_3 and rod HA are rigidly connected. Also the resultant velocity of P on the planet wheel must be equal and parallel to AB, and thus must also be the linear velocity of P on the sun wheel D_1. Therefore, the angular velocities of driver and follower will be $\frac{AB}{AM}$ and $\frac{PE}{PM}$, and the ratio of turns of the driver to the fol-

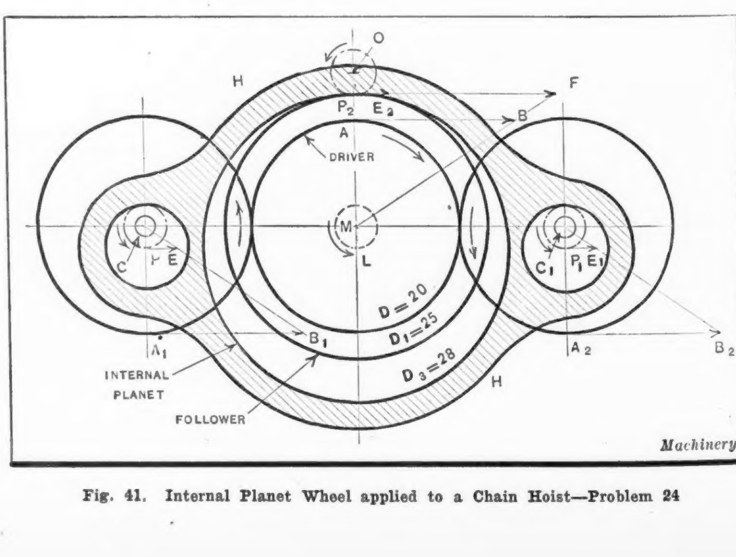


Fig. 41. Internal Planet Wheel applied to a Chain Hoist—Problem 24

lower will be $N = \frac{AB}{AM} \times \frac{PM}{PE} = \frac{1}{2}$, the same as found for the phase illustrated in Fig. 38.

Determining Velocity Changes between Driver and Follower Due to Angularity of Connecting-rod

In the foregoing, the Watt sun and planet wheels were specially operated by a drive rod that always remained parallel to itself. When an ordinary connecting-rod is used instead of the drive rod, as shown in Fig. 37, the sun wheel D_1 still makes exactly two turns while the driving crankpin A makes one turn, but the follower sun wheel has a variable angular velocity instead of a constant velocity. A graphical method of determining the angular velocity in this case is shown in Fig. 37. Let AB represent the linear velocity of the crankpin A, which is assumed to be constant. This velocity, it may be noted in passing, is derived, as shown, from the cross-head velocity HB_2 of an engine, or, as in the case in which Watt used it, from the end of a "working beam" which was pivoted to the connecting-rod at H. In solving the present problem, it is necessary to find the resultant velocity of P on the planet wheel D_3. When this is found, the problem is practically solved, for the resultant motion of P on the follower sun wheel must be the same as the motion of P on the planet wheel.

Since the planet wheel is a rigid part of the connecting-rod, and since the resultant motions, AB and HB_2 of two points on this part are known, the instantaneous axis for the part may be found, as explained in a preceding paragraph, by drawing perpendiculars to these lines as shown at AI and HI. The point I then is the instantaneous axis for the rod and planet wheel, and PE is the resultant velocity of both P on the planet wheel and P on the sun wheel D_1. The relatively angular velocities of the driving crankpin and the sun wheel may now be written as $\frac{AB}{AM}$ and $\frac{PE}{PM}$, respectively, or, reducing velocity AB to the unit radius of PM, $N' = \frac{PF}{PE}$.

Measuring these values to scale, it is found that at this phase the follower is turning at about 1 2/3 the speed of the driver, instead of at double the speed, as was the case in Fig. 39. Since the sun wheel must make exactly two turns while the driving crankpin makes one, and since the follower is going slower than a 2 to 1 rate at the phase shown in Fig. 37, it follows that at some other phase the follower must be going at a greater than 2 to 1 rate. This may be demonstrated readily by drawing, in other quadrants, a graphical construction similar to that shown in Fig. 37. From such constructions a velocity diagram may be drawn as shown in Fig. 37, where with the proportions of wheel diameters and connecting-rod length used in this problem, it may be seen that the follower is turning at the rate of 2.35 times that of the driver at the zero position; at the exact rate of 2 times at 90 degrees; and at the rate of 1.65 times at 180 degrees. Such changes in angular velocity of a follower would prove troublesome in high-speed engines or machinery.

Analytical Method Applied to Watt's Sun and Planet Wheels

The analytical method of solving planetary gear problems may be applied to Watt's sun and planet wheels as readily as to other planetary problems, and the formula is just as simple. It requires, however, special treatment, because the Watt mechanism does not have a fixed wheel, as nearly all other planetary mechanisms have. In Watt's mechanism the planet wheel is the driver, and when the drive rod connected to it remains parallel, the planet wheel has a motion known as circular translation, as it moves around the central sun wheel. Circular translation is such a motion of the planet wheel as would cause a vertical line drawn on the face of the wheel to remain vertical all the time, while the planet wheel moves around the sun wheel. It follows, in such a motion of the planet wheel, that there can be no turning of the planet wheel on its own center.

Therefore, in writing the formula for solving this kind of analytical problem we may proceed, as in other problems up to the point $N = 1$. This means that all parts have been rotated as one solid piece about the main center M, Fig. 38, and that the planet wheel D_3 has turned once on its own center. In the actual working of the mechanism, the planet wheel has a motion of circular translation, and no rotation on its own center. The planet wheel, therefore, is now turned back counter-clockwise one full turn. The sun wheel is thereby turned clockwise, and the formula is now written $N = 1 +$. The amount the sun wheel is turned back is $\frac{D_3}{D_1}$ turns, and the formula is now finally written $N = 1 + \frac{D_3}{D_1}$. If both wheels are the same size with, say, 24 teeth, $N' = 1 + \frac{24}{24} = 2$, or the follower makes two turns to one of the driver. If the planet wheel has 16 teeth, while the sun wheel has 24 teeth, $N' = 1 + \frac{16}{24} = 1\ 2/3$. In a similar manner it may be shown that a very slight increase in follower speed could be obtained by making the planet wheel very small; or, a large increase could be obtained by making the planet wheel very large comparatively.

Internal Planet Wheel with Motion of Circular Translation

A planetary gear mechanism that employs a different form of mechanical construction from any thus far considered, but that is the same in principle as Watt's sun and planet gear, with an infinite drive rod and an internal planet wheel instead of an external one, is illustrated in Fig. 40. The drive rod HH' is parallel in all positions; therefore, the planet wheel D_3 has a motion of circular translation, and its center L travels counter-clockwise in the path of the circle LP. The point A on D_3 travels similarly to L, and at the phase shown, has a velocity AB about the center O. The velocity of point A on the gear wheel D_1 is also AB, but about the center M. Since the linear velocities of the two wheels must be taken at the same radial distance to compare angular velocities, and since the radial distance for A of D_3 is OA, the same radial distance must be taken at MP to find the angular velocity PE of D_1. Then AB and PE may be directly compared, and $N = \frac{-AB}{+PE} = -2.5$ approximately; in other words, it takes 2.5 turns of the planet wheel D_3 counter-clockwise to turn the follower wheel D_1 once in a clockwise direction. The analytical solution for the problem is readily set down, as explained in the preceding paragraph; thus $N' = 1 - \frac{42}{30} = -\frac{2}{5}$, or $N = -2.5$.

Practical Application of Internal Planet Wheel Principle—Problem 24

The application of the principle illustrated in Fig. 40 is shown in Fig. 41 in connection with the "Cyclone" chain hoist. The wheel D is fastened to the drive shaft and is in gear with two other wheels of equal size, as shown at A_1 and A_2. These two wheels are in line at one end of the gear-box and they have shafts running through to the other end of the box. On the front end of these shafts are mounted the eccentrics P and P_1 which drive the cross-sectioned member H with a motion of circular translation. On H is cut an internal gear wheel D_3 which drives the wheel D_1, the latter being keyed to the follower shaft.

Problem 24—The wheels D, A_1, and A_2 each have 20 teeth, D_1 has 25 teeth, and D_3, 28 teeth. Determine the value of N by the graphical, analytical, and geometrical methods.

A graphical analysis of the chain hoist described in the preceding paragraph, and illustrated in Fig. 41, starts with

the linear velocity AB of the drive shaft wheel D. The same velocity is mechanically reproduced at A_1 and A_2. From these velocities, the equal velocities PE and P_1E_1 of the centers of the eccentric sheaves are found. The latter velocities are common to all points of the piece H and, consequently, P_2E_2, equal to P_1E_1, may be drawn at P_2. The velocity of P_2 on the follower wheel D_1 is then equal to P_2E_2 also. Taking P_2M as the unit radius for comparing angular velocities, the original linear driving velocity AB must be increased to P_2F. Remembering that the point P_2 on the piece H is traveling in the path of the small circle whose center is at O, it will be noted that P_2 on the piece H is traveling in a counter-lockwise direction, and therefore that the velocity P_2E_2 must be written with a minus sign before it. The point P_2 on D_1 is traveling clockwise, and therefore $N = \frac{P_2F}{P_2E_2}$. If the drawing is made accurately to scale and the lines P_2F and P_2E_2 are measured, it will be found that $N = 8\ 1/3$.

The analytical solution is obtained by writing the formula directly, in accordance with the explanation previously given; thus

$$N' = 1 - \frac{28}{25} = -\frac{3}{25} \text{ or } N = -8\ 1/3$$

The value of N in this case is minus, because this formula takes into account the direction of turning of the intermediate driving wheels and eccentrics at C and C_1. These wheels and eccentrics, however, are driven by the wheel D which turns clockwise, the same as D_1. Therefore, when the wheels D and D_1 are compared, $N = +8\ 1/3$.

The geometrical solution for problems of such an unusual type as the one just described is of special value as an insurance that no error has been made in the processes involved in the somewhat elusive analytical method. Referring to Fig. 41 and to the velocity lines that have been drawn for the graphical method, $N = \frac{P_2F}{P_2E_2}$. Assuming any length, say 6 inches, for the velocity line AB, it follows from the methods explained in the graphical construction, that $A_2B_2 = 6$. From the data for Problem 24, $C_1P_1 = ML$,

$$LP_2 - MP_2 = 14 - 12.5 = 1.5 \quad \text{and} \quad C_1A_2 = MA = 10$$

$$\frac{P_1E_1}{A_2B_2} = \frac{C_1P_1}{C_1A_2} \text{ and } P_1E_1 = \frac{1.5 \times 6}{10} = 0.9$$

Therefore

$$P_2E_2 = P_1E_1 = 0.9$$

$$\frac{P_2F}{AB} = \frac{P_2M}{AM} \text{ and } P_2F = \frac{12.5 \times 6}{10} = 7.5$$

$$N = \frac{P_2F}{P_2E_2} = \frac{7.5}{0.9} = 8\ 1/3$$

* * *

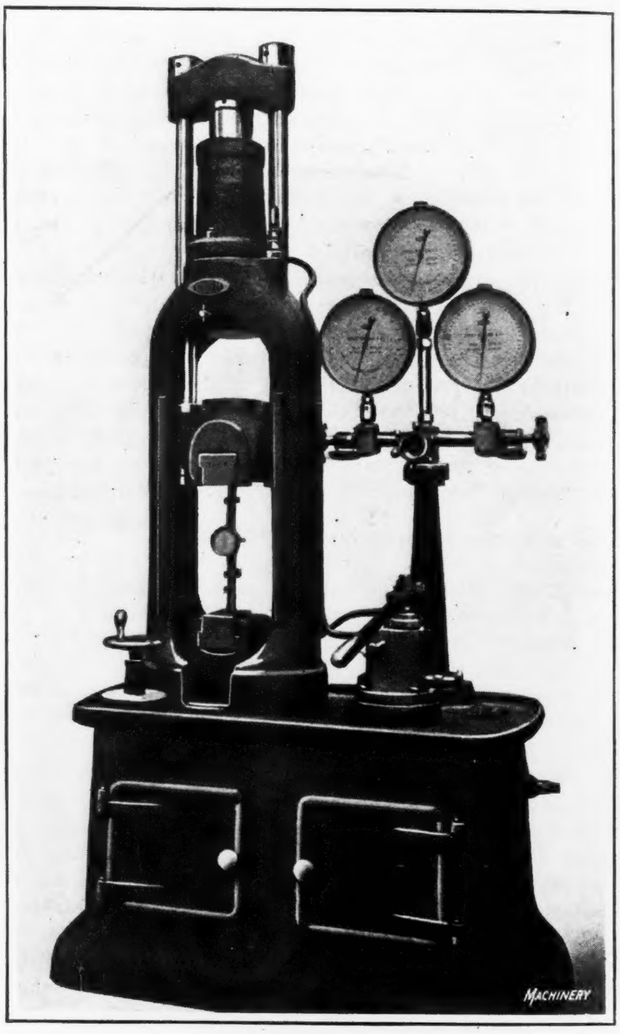
HYDRAULIC TESTING MACHINE

The hydraulic testing machine shown in the accompanying illustration has recently been developed by a German concern under what is known as the "Schiller" patent. This machine is intended primarily for use in laboratories and purchasing offices for making tensile, compression, Brinell, bending, folding, drift, and shear tests involving pressures up to 35 tons. The required pressure is obtained either by means of the hand pump provided as part of the regular equipment or an electric pump attachment.

The pressure cylinder is located at the top of the test column and is connected by a cross-head and two draw-bars with the testing socket which moves freely in the guides of the main column. In making tensile tests, the rod is subjected to a straight pull with no supplementary torsion. The lower socket can be moved up or down in the column by means of a handwheel located at the left-hand side of the base. The maximum working range or space for tensile testing is 600 millimeters, or approximately 23.62 inches.

A special bending socket is provided which permits bending tests to be made with a maximum distance between centers of one meter (39.37 inches) with the full power of 35 tons. Special attachments are also employed for bending and folding tests. The maximum height of the pressure-testing field is 225 millimeters, or about 8.85 inches. Measurements can be taken by a rough tensile indicator and a specially constructed fine indicator that records measurements of 0.001 millimeter (0.00003937 inch). These instruments permit elasticity, proportion, and maximum tension limits to be accurately determined.

It is recommended that an electric pump be provided if the machine is to be used continuously for tensile tests.



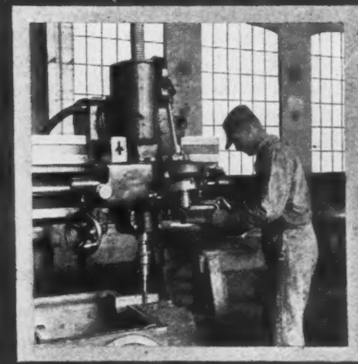
Hydraulic Testing Machine

When desired, a subsidiary pressure tank is supplied, which makes it possible to test ten rods in succession without replenishing the pressure. When the oil-pump is in operation, it compresses the nitrogen in the pressure tank to about 500 atmospheres, and as the nitrogen expands, the oil is forced through an inlet valve into the pressure cylinder. The force is measured by three spring gages which have dials graduated to read up to 2, 10, and 35 tons pressure, respectively, or the force may be measured by a pendulum gage.

* * *

The Standardization Committee of the German Industry, (Normenausschuss der Deutschen Industrie), has published a book of 108 pages covering standard keys and keyways in a very thorough manner. Those interested can obtain this book, which, of course, is published in German, by addressing Dinorm, Sommerstrasse 4a, Berlin, NW 7, Germany. The price is three gold marks ($0.72).

Letters on Practical Subjects



ROLLING THREADS ON SHEET-METAL SHELLS

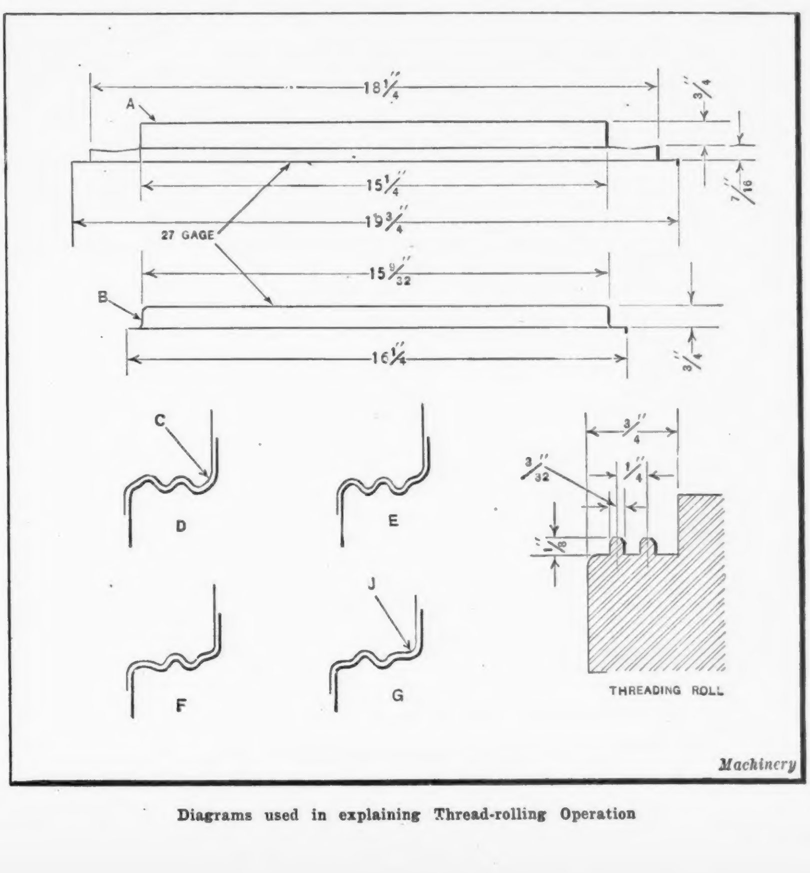
Articles describing methods of rolling threads on metal shells have appeared in MACHINERY from time to time, but the methods described have generally been applied to thread rolling operations on shells of comparatively small diameters, such as are used for screw tops for containers. The object of the present article is to describe the modifications of the regular practice found necessary by the writer in rolling threads on thin metal shells of unusually large diameters. These shells, two of which are shown at *A* and *B* in the illustration, are the head and cap, respectively, of a sheet-metal drum or container. The writer has been told that thread rolling on parts of this kind is seldom attempted, as it has been found very difficult to obtain good threads on shells having such a large diameter in proportion to the thickness of the metal.

In the beginning it was assumed that the cap must be somewhat smaller than the head in order to be screwed on easily. Accordingly, the dies were made so that there was a clearance of about 1/32 inch between the cap and the head before threading. It was expected that this looseness or clearance would be lessened when the thread rolling operation was performed. However, instead of the 1/32 inch clearance there was a clearance of 3/32 inch after the rolling operation. The cap seemed to close in and the head to expand during the rolling operation. The thin flexible nature of the stock made it practically impossible to measure the pieces accurately. By gradually changing the diameter of the shell, the point was reached where the cap was larger than the hole in the head, and it was necessary to force the cap into the head before rolling the thread on the two assembled members. In this case the threads were rolled on the two members simultaneously. When this method was employed the cap could be easily turned or unscrewed from the head, provided the threading rolls were correctly adjusted. If the rolls did not come together or mesh deep enough, the parts would be threaded tightly together, but if the rolls were set too deep, there would be considerable looseness between the threaded parts.

The form of the thread on the rolls used in rolling the threads on the work shown in the illustration is somewhat different from that ordinarily employed. Both rolls have a clearance at the bottom of the threads, and the form or contour of the thread is the same on both. The dimensions of the thread are given in the view at the lower right-hand corner of the illustration. The diameter of the front roll is such that the work can be easily slipped off after the thread has been rolled. Considerable trouble was caused by the breaking of the tops at point *C*, view *D*. The break was not caused by a cut, but was a pulling apart of the metal. Although the metal was thin, being 28-gage stock, and was put through a difficult drawing operation, there were times when a great many pieces would be threaded without breaking.

The method of preventing this breakage was to cut off part of the thread on the back roll, as indicated at *J*, view *G*, so that the thread did not come so close to the shoulder. This made the change from the flat to the round surface more gradual and allowed a more flexible control of the work during the rolling operation. The length of the thread was reduced, of course, but there still remain one full turn and a half turn of the thread, which was considered much better than two poorly fitted threads. At *D*, *E*, *F*, and *G* are shown sections of the assembled threaded parts at four evenly spaced points. Referring to view *G*, it will be evident that if the thread on the back roll had been left full, the two parts would be pressed tightly together at the flat or flanged section where the breakage usually occurred.

The views at *D*, *E*, *F*, and *G* were carefully made from a head and cap that had been spot-welded together and sawed



Diagrams used in explaining Thread-rolling Operation

through in four places. These views give a good idea of the depth of the thread and its form at the four evenly spaced positions. After the back roll was changed as described, no further trouble was experienced from breakage. It is possible to obtain a good deep thread which will prevent the cap from being knocked out without deforming the roll top of the container. This was an important requirement which could not be overlooked.

Memphis, Tenn. JAMES ELLIS

FORMING DIE FOR RIM ENDS

The die shown in Fig. 3 was designed by the writer for the purpose of bending the ends of the rim *A* to an angle of approximately 90 degrees and at the same time forming or curling sides of the bent portion as shown in Fig. 1. The formed ends are subsequently pierced so that they serve as eyelets for screws that fasten the rim to another member.

In performing the bending and forming operation, the rim is located in grooves in the die members *B* and *C* with the ends in contact with the locating pad *D*, as shown in Fig. 2. When the punch descends, the hold-down blocks *E* and *F*, backed up by springs *G* and *H*, come in contact with the work and press it down firmly in the grooves in blocks *B* and *C* while the punch *J* forms or curls the sides of the ends, and bends the ends down. Referring to the side view

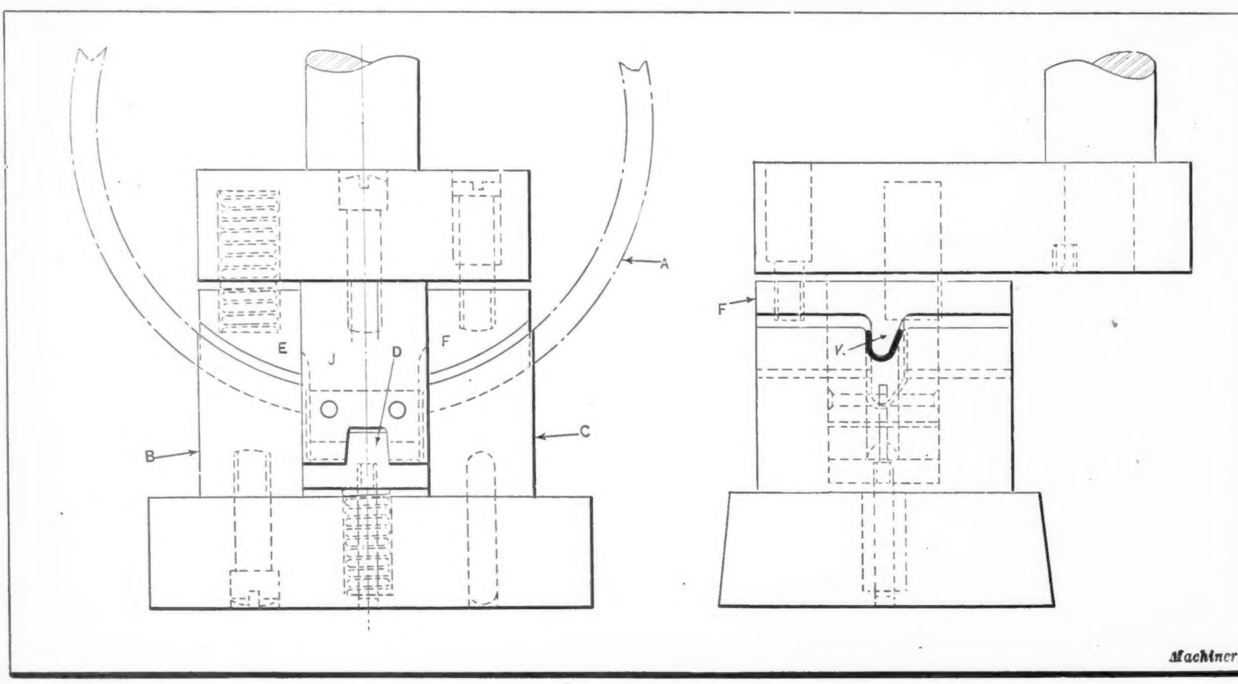


Fig. 3. Complete Front and Side Views of Die shown in Fig. 2

in Fig. 3, it will be noted that the hold-down blocks *E* and *F* have a projecting rim at *K*, which fits the inner side of rim *A* so that it is held securely in place.

In Fig. 2 it will be seen that there is a groove across the end or bottom of punch *J* and at both sides. The plate *L*, which is set in a slot in the end of the punch and riveted in place, extends into the grooves at the end and sides of the punch. This plate is 1/16 inch thick, and serves to keep the curled sides of the bent ends 1/16 inch apart when the ends are forced against it and ironed out at the completion of the downward stroke of the punch. It will be noted from Fig. 3

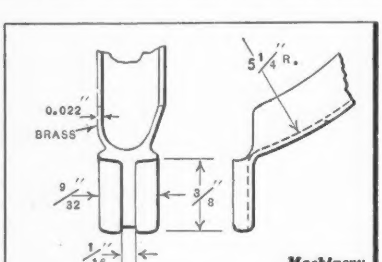


Fig. 1. Formed End of Rim

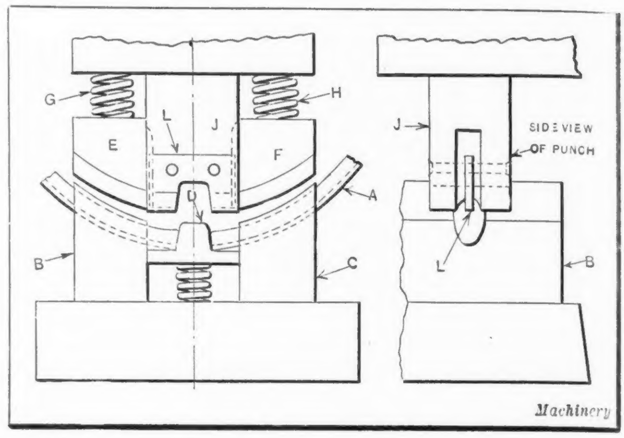


Fig. 2. Rim-end Forming Die

that the punch is offset so that the work clears the ram when it is properly located in the die.

Los Angeles, Cal. BEN FRANTZREB

ELLIPTICAL TURNING DEVICE

In Fig. 1 is shown an engine lathe provided with an attachment for use in making dies for the cutting or forming of elliptical blanks or cup-shaped pieces such as are used for kitchen utensils, headlight reflectors, and various other products having similar shapes. This attachment is so designed that it can be adjusted to bore or turn out elliptical shaped cavities in dies having major and minor axes of any desired length within the capacity of the device. With slight modifications it can be employed on the milling machine, boring mill, shaper, or planer.

The principle of the design is the same as that used in geometry for drawing an ellipse, where the major and minor axes are divided into equal parts and the intersection of the projected points of the two respective circles (whose diameters are the two axes) give the points through which the outline of the ellipse may be drawn. When the device is in operation, the point of the cutting tool follows the outline that would be generated by using axes corresponding to the throw of the two controlling crankpins *I* and *J*.

When the elliptical turning device is used on an engine lathe, the toolpost and other equipment is removed from the carriage, thus providing a clear surface on which to mount

the attachment. The gearing that connects the operating shafts must be designed to suit the machine on which the device is to be used. The base *A* is provided with a slide on which the member *B* is free to move at right angles to the lathe spindle. The upper surface of this cross-member is also provided with a dovetail slot to accommodate the lateral sliding member *C*, which moves in a path parallel to the axis of the lathe spindle. On this piece is mounted the toolpost rest *D*, which has a limited movement at right angles to the lathe spindle to provide for crosswise adjustment of the cutting tool.

On the outer end of the movable pieces *B* and *C* are slots *E* and *F* which have their machined sides at right angles to the direction of the movement of their respective slides. In these slots are fitted sliding blocks *G* and *H*, through the centers of which pass the crankpins *I* and *J*. These pins have square heads which may be clamped in T-slots in the disks *K* and *L*; the disks are mounted on shafts that pass down through bearings in arms that extend from the base and the lower sliding member *B*. A worm-wheel *M* is keyed to the lower end of the shaft on which disk *K* is mounted. This worm-wheel meshes with the worm *N* keyed to shaft *O*, the opposite end of which carries the bevel pinion *P* which meshes with the pinion *Q* of the vertical driving shaft. The lower end of the sleeve pinion *Q* is provided with clutch teeth which may be engaged with the teeth of the sliding clutch collar *R* by moving the latter member upward. Collar *R* is prevented from turning on its shaft by a key, and is knurled on the outside. A similar clutch control is also provided for the gearing that drives disk *L* through pinion *S*, shaft *T*, and worm *U*, the latter being feathered in a long keyway cut in shaft *T*.

The bracket *V* is bolted to the apron, and in addition to providing a bearing for the vertical driving shaft, has a forked piece extending downward on the inner side of the lower bushing which supports the worm located on the main driving shaft *W*. The meshing worm-wheel *X* is keyed to the short vertical driving shaft. When the device is in operation, the work, which is preferably roughed to shape in a previous operation, is mounted on the faceplate, and the crank disks *K* and *L* are properly set for the particular shape that is to be turned.

In the example shown in Fig. 1. the crankpins are located on the quarters or sections nearest the operator. The throw of pin *I* in disk *K* controls the mouth diameter of the cavity in the die, which in this instance is the major axis. The throw of pin *J* in disk *L* is adjusted to give the cavity the proper depth, which in this instance is equal to one-half the minor axis. The turning tool is set in approximately the correct position and securely clamped in the toolpost. A further adjustment of the tool is obtained by the cross-feed of the tool-slide and the lateral movement of the lathe saddle. When the device is in operation, the carriage is firmly clamped to the lathe bed.

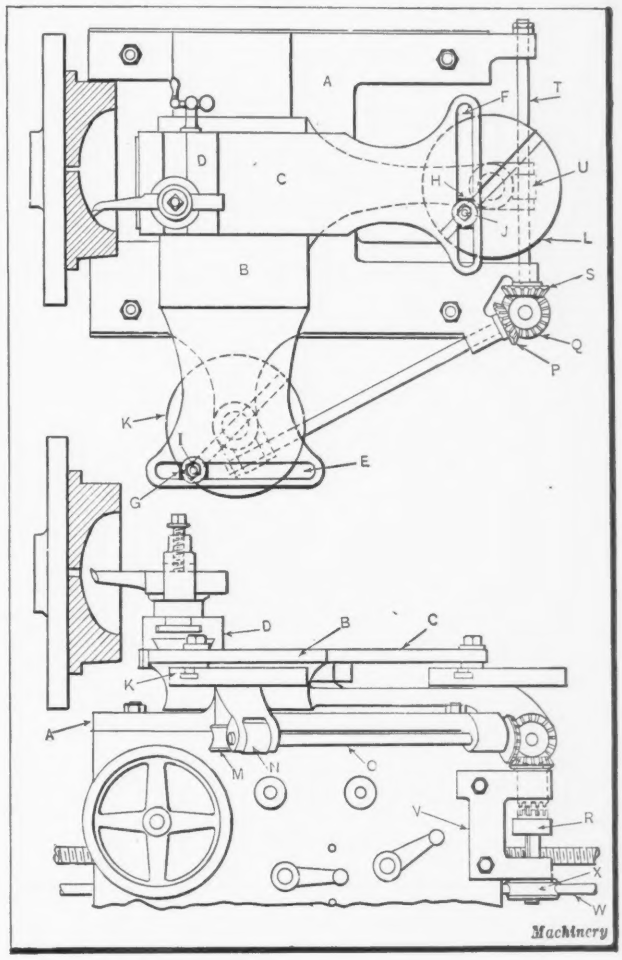


Fig. 1. Elliptical Turning Device for machining Dies

By locating pins *I* and *J* at different distances from the centers of disks *K* and *L*, and by starting the cut with the pins in different positions, it is possible to develop a great variety of shapes. The various shapes are, of course, based on the ellipse, the major and minor axes of which can be made to meet requirements. If the throw of the crankpins *I* and *J* is the same, the tool will follow a circular path, and the cavity turned in the die will be semi-spherical.

In Figs. 2 and 3, the setting and the starting positions of the crankpins for turning different shapes are shown diagrammatically. The diagram Fig. 3 shows the setting and starting points for turning an elliptical shaped cavity having a mouth diameter equal to the minor axis and the depth of the cavity equal to one-half the major axis. The starting points of the cranks and the tool are indicated by the figure 0. The path of each crank is represented by a

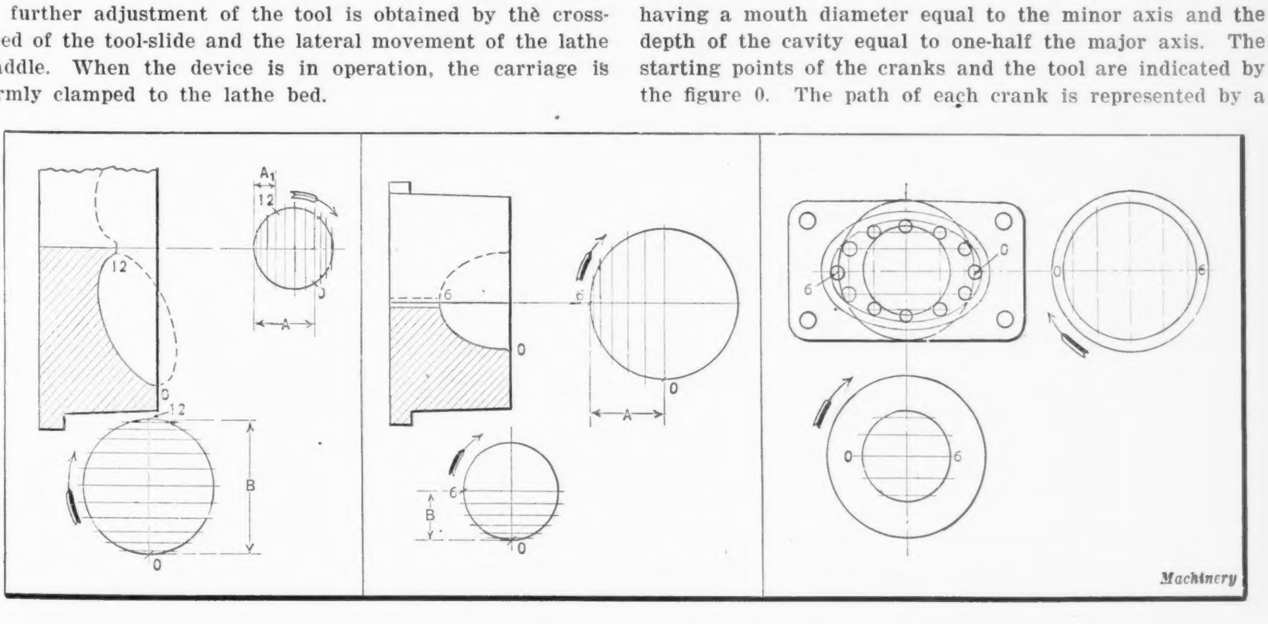


Fig. 2. Setting of Crankpins for turning Cavity of Unusual Form

Fig. 3. Setting of Crankpins for turning Deep Elliptical Cavity

Fig. 4. Lay-out of Work and Setting of Crankpins for Elliptical Milling

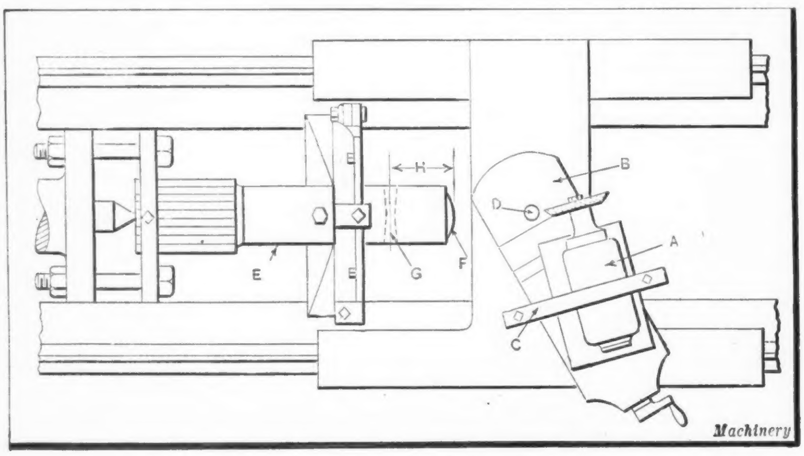
circle, the direction in which the crankpin moves being indicated by an arrow. The combined movements of the two slides imparted by the crankpins I and J in this case cause the turning tool to follow the path from 0 to 6.

In Fig. 2 is shown a die having a cavity of rather an unusual shape. In this case also, the starting points of the crankpins are indicated by 0, the movement being from 0 to 12. It will be noted that the crankpin that controls the depth of the bowl moves forward a distance A and then back a distance A_1, while the other crank moves the tool crosswise a distance equivalent to dimension B. When the attachment is employed for milling machine work, the die is mounted on a suitable table as shown in Fig. 4. In this case the diameter of the milling cutter must be allowed for when setting the crankpins in the disks K and L.

J. R. HENDERSON

RADIUS-GRINDING SHANK END OF FLOATING REAMER

One of the most difficult grinding jobs that the writer has ever attempted to do on a lathe was the grinding of a spherical seat on the shank end of a floating reamer. The set-up for this operation is shown in the accompanying illustration. The small electric grinder A was secured to the wood block B by means of clamp C. Block B was placed on



Lathe equipped for grinding the Spherical End of a Reamer

the compound rest and held in position by the pivot-pin D. The reamer E was supported at the left-hand end by the center in the lathe faceplate and at the right-hand end by a steadyrest. The spherical end of the reamer at F was required to be ground to a radius of 5/8 inch. The cutting edge of the grinding wheel was therefore set with a size-block to a distance of 5/8 inch from the center of pin D so that the spherical surface was ground to the required radius when block B was pivoted on pin D.

The tolerance on dimension H from the center of hole G to the end of the conical surface F was so small that particular care had to be taken in performing the grinding operation. In order to obtain the required accuracy, a straight collar was made up having a length about 1/8 inch greater than the distance from the center of hole G to the end of surface F minus one-half the diameter of a 5/16-inch plug gage. The hole in this collar was machined to a slip fit over the end of the reamer. As hole G was tapered from both ends, the 5/16-inch plug gage served to keep the collar in the correct position when measuring the distance from the end of the collar to the end of surface F with a depth micrometer.

Cleveland, Ohio WILLIAM WILSON

JACK FOR IMPRESSING EMBOSSING DIES

The hydraulic jacks here illustrated are similar to some designed by the writer for forcing hardened hobs into tool-steel blocks to produce forming and embossing dies for

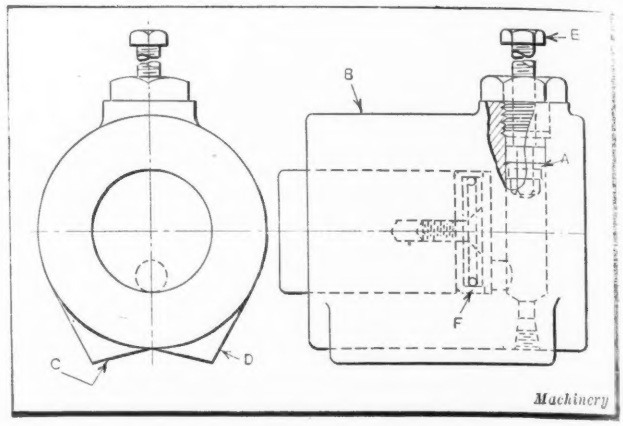


Fig. 1. Screw-and-plunger Operated Jack

jewelry shop work. Hobs that are duplicates of the pieces desired are forced into the tool steel as a signet is forced into wax. The tool steel is then hardened and the impression polished, after which the die is ready for use in the production of embossed articles in gold and silver. The impressing of the hobs in the die-blocks requires a pressure of several tons. It is desirable that the jacks used to obtain this pressure be small and as light in weight as possible.

The principle on which these jacks work is essentially the same as that on which the hydrostatic press operates. The fluid used is preferably tallow, although a solid hydrocarbon may be employed. Three separate means for multiplying the force applied to the jacks are involved in obtaining the high pressures required. These are the hydrostatic action obtained when forcing the tallow or other fluid from the small cylinder into the larger ram cylinder, the wedge action of the thread on the plunger in the small cylinder, and the lever or wheel and axle arrangement used to turn the threaded plunger. By using these means of multiplying the applied force, it is possible to obtain pressures two thousand times as great as the pressure applied to the jack.

The advantages of using tallow as an operating fluid in these jacks are that it does not freeze, vaporize, or leak through cracks as readily as water. In addition, the leather packing will last almost indefinitely when tallow is used. When desired, the tallow can be quickly melted and allowed to run out through an opening which is ordinarily closed by means of a pipe plug. The ram of the jack illustrated in Fig. 1 has a short travel, but this can be increased by lengthening the boss and the cylinder of the operating screw, or by using two or more operating screws, without any change in the ratio between the applied and the effective pressures. The body B of the jack is made of cast iron, and has two longi-

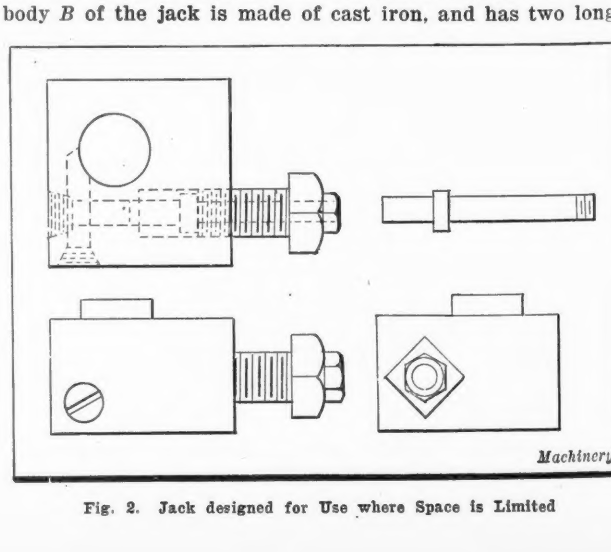


Fig. 2. Jack designed for Use where Space is Limited

tudinal ribs C and D that form a wide-angle vee, which facilitates locating the ram parallel with the shaft when the jack is used for pressing gears on or off shafts.

The casehardened operating screw E which forces the tallow into the main cylinder of the ram is provided with a leather cup-shaped washer, as shown at A, and a similar washer is provided at F for the ram plunger. It is preferable to make leather washers from willow calf skin, but if this is not available the uppers of old shoes may be used. The leather can be molded to the required cup shape in wooden molds by squeezing it while wet into the mold and allowing it to dry before being removed from the mold. In the smaller jack shown in Fig. 2, the cup leather is replaced by a plunger having a "sucking" fit in the cylinder. The smaller jack is designed for use where the space would not permit the use of the larger type of jack. The suction exerted on the rams when the operating screws are turned out causes the rams to recede and also prevents them from falling out when the jacks are not in use.

Willimantic, Conn. HERBERT A. FREEMAN

INDEXING TECHNICAL ARTICLES

A card index made up of cards like the one illustrated enables one to find quickly any article in a library of technical, trade, and engineering magazines. This method of

DATA ON *Interchangeable Counterbores* FILE UNDER C

INDEX NO.	FOUND IN: BOOK OR MAGAZINE	VOL.	NO.	PAGE	REFERS TO
C.8	Machinery, Aug. 1924	30	12	943	Operations and fixtures used in making counterbores and holders.
C.9					

Card used in Index File for Technical Articles

indexing also permits the magazines to be kept intact and bound in yearly volumes. While the index sheets are supplied for binding with the magazines, it is sometimes necessary to search through several bound volumes before a certain article can be found. The pouch method of filing articles is good in that it keeps all related subjects together, but it has the disadvantage of necessitating the sorting over of the articles when looking for information on some particular subject. Before the card index system was devised the writer often spent considerable time in searching for articles pertaining to his work which he had remembered reading in one of the technical or trade magazines.

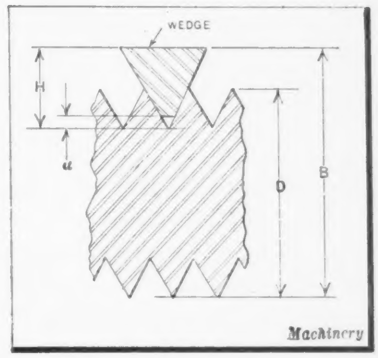
The method of indexing will be understood by referring to the illustration. It will be noted that the top line is used for the subject of the article; after that there is a space for a letter which indicates the position of the card in the file. In a column headed "Index No." is given the initial letter of the subject and the number of the article. The notation C.8, for instance, signifies that the article on interchangeable counterbores which appeared in August, 1924, MACHINERY is the eighth article filed under the subject of interchangeable counterbores. It will be noted that columns are provided for the volume, number, and page of each article. A brief synopsis of the article which will serve to distinguish it from others on the same subject is given in the column on the extreme right. The cards are convenient to handle, and enable the desired material to be quickly located.

New Brunswick, N. J. H. P. GASSIN

WEDGE SYSTEM FOR MEASURING THREADS

The wedge system of measuring threads presented herewith has been found very useful by the writer. This is similar to the one-wire system except that a wedge-shaped piece is used instead of a wire. Referring to the accompanying illustration, we have

H = altitude of 60-degree wedge;
B = micrometer measurement;
D = outside diameter of thread;
N = number of threads per inch.



Using a Wedge instead of Wire for Thread Measuring

The point of the wedge must be flattened so that there is a clearance a that will permit the wedge to clear the flat at the root of a U. S. standard thread. For the U. S. standard thread we have,

$$B = D - \frac{0.7577}{N} + H$$

and for the sharp V-thread we have,

$$B = D - \frac{0.866}{N} + H$$

These formulas give the correct micrometer readings for dimension B when the thread angle and the pitch diameter of the thread are correct. With this system of measuring only one wedge is required for practically all sizes or pitches. The wedge also serves as a check on the thread angle.

Philadelphia, Pa. CHARLES KUGLER

RUNNING-IN MACHINE FOR TRANSMISSION GEARS

In Fig. 2 is shown a running-in machine used to secure the quiet operation of gears such as shown at E and F after

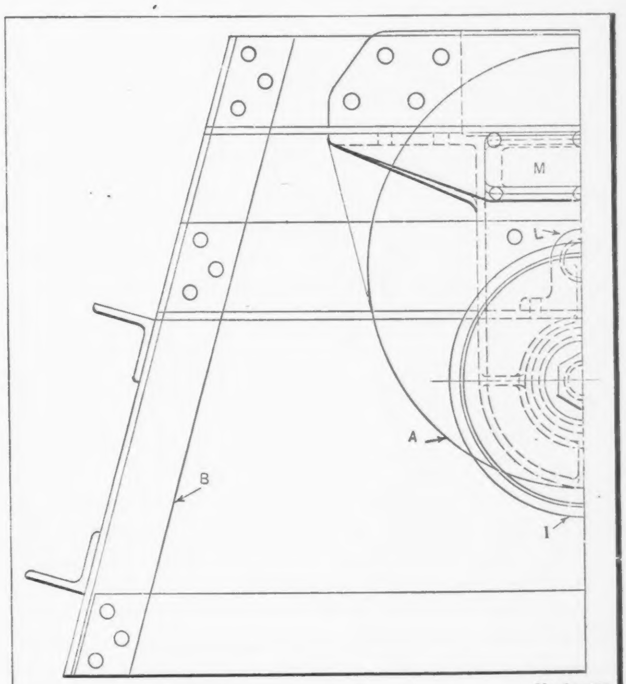


Fig. 1. Angle-iron Frame of Running-in Machine shown in Fig. 2

they are assembled in the transmission case of an electric truck of the light-weight type. These gears are required to run very smoothly and quietly. For this reason they are made with ground helical teeth having a helix angle of 7 degrees. It was found that the gears operated quietly after from two to four months road use. By running the gears in before assembling them in the transmission case, the advantage of quiet operation is obtained right from the start.

The running-in machine was constructed by mounting a stock transmission housing *A*, Figs. 1 and 2, on an angle-iron frame *B* and providing the driving shaft of the transmission with a pulley that could be driven from an overhead lineshaft. In place of the electric motor used to drive the truck, a plate *C* was provided. This plate was so designed that it could be readily removed in order to permit changing the gears *E* and *F*.

a thick felt washer at the end of each bearing. All of the bearing housings are provided with pipe taps for alemite fittings, and when these are kept filled with grease, there is little chance for emery charged oil to enter the bearings.

When putting a new set of gears in the running-in machine after one set has been properly run in, the first step is to remove plate *C*. The pinion *E*, which is withdrawn with the plate, is then removed and replaced by a new gear, and the gear *F* is also replaced by another gear. Machine oil and ground emery is used for the running-in operation, and is put in through the opening *M* and drained out through plug *N* before removing plate *C*. The spring tension used to obtain the proper running-in action has been found more satisfactory than the usual pulley-and-shoe brake arrangement which does not always give an even tension, and which wears out rapidly. The running-in machine itself is quiet in operation and permits the use of a detectograph on the housing in order to determine the amount of noise caused by the gears at different periods of the running-in operation.

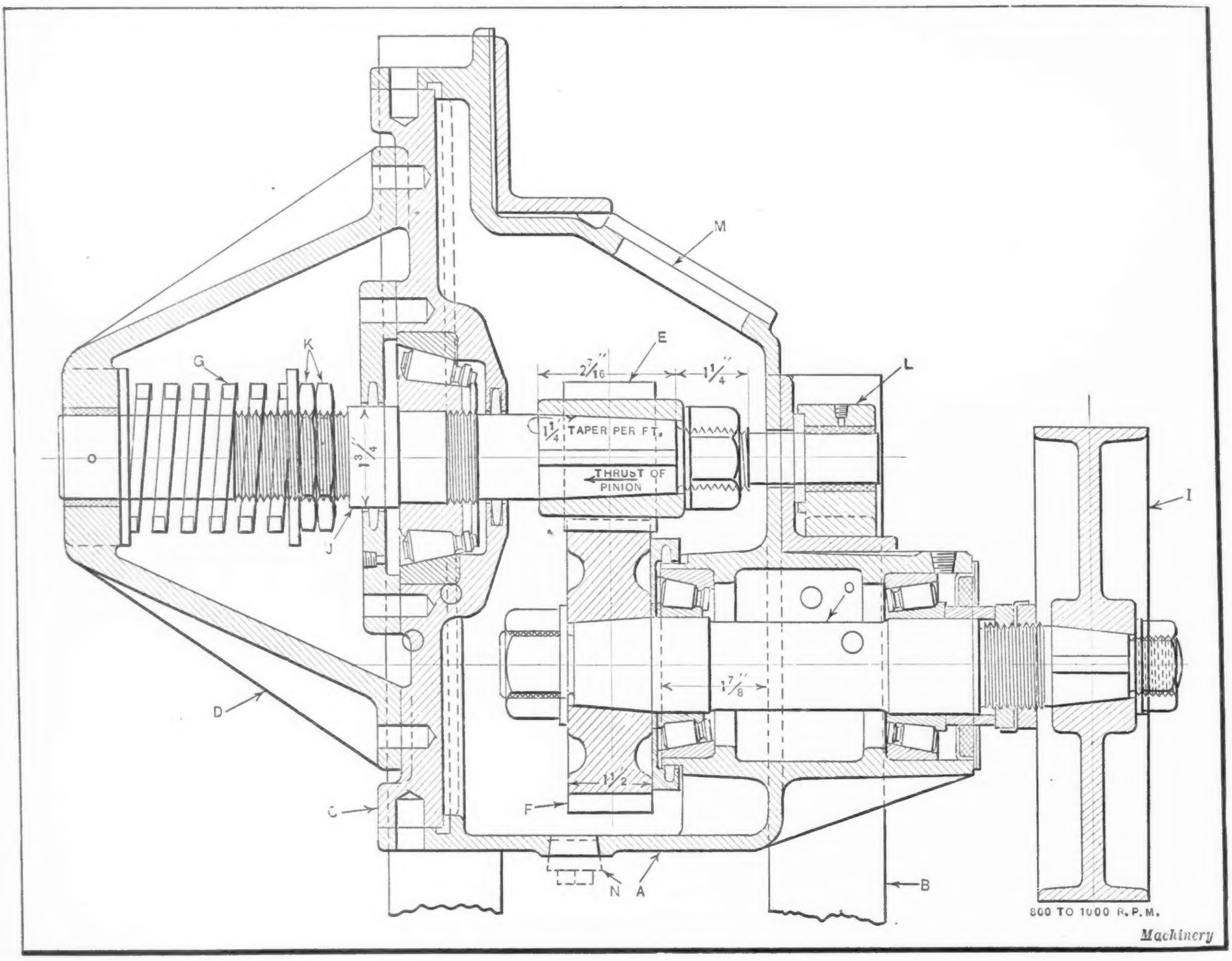


Fig. 2. Running-in Machine for Transmission Gears

Referring to Fig. 2, it will be noted that an extra large Timken roller bearing is mounted on the removable cover. This bearing is fully enclosed and provided with a lubricating pipe. In order to place a certain amount of tension on the pinion *E*, so that it will not just float while being driven by gear *F* through shaft *O* and pulley *I*, a spring *G* was put on the pinion shaft *J* between the lock-nuts *K* and bracket *D*. This spring and the lock-nut arrangement provided a means for adjusting the tension on the roller bearing. Both sides of the bracket *D* were left open in order to permit the lock-nuts *K* to be adjusted from the outside of the housing. Pulley *I* is attached to transmission shaft *O* in place of the regular universal joint, shaft *O* being the same as that used in the regular electric truck transmission system. The bearing *L* was placed on an angle-iron outside of the housing to insure accurate centering of plate *C*.

One of the problems encountered in designing the running-in fixture was that of providing means for keeping the emery oil out of the bearings. This was accomplished by using

Roselle, N. J. W. R. Graham

* * *

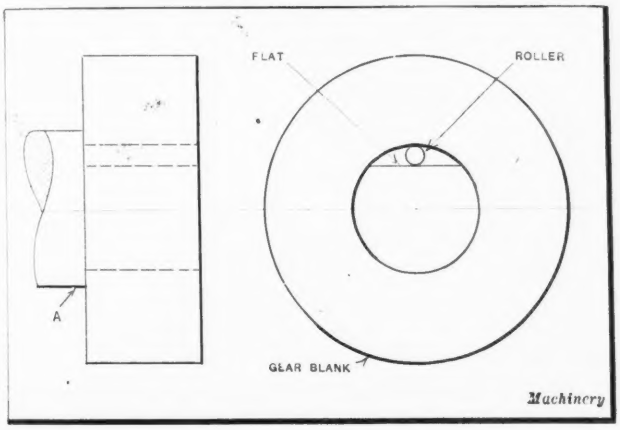
In 1923 Great Britain bought more than $14,500,000 worth of industrial machinery (excluding electrical and agricultural equipment) from the United States. Of this total, $2,450,000 represented metal-working machinery, this being approximately one-sixth of the total American exports of metal-working machinery. The importance of Great Britain as a market for American metal-working machinery is further shown by the fact that in 1923 over one-half of the metal-working machinery shipped to the whole of Europe was exported to the United Kingdom. In 1924 there was a considerable increase in the exports of metal-working machinery, as compared with 1923.

Shop and Drafting-room Kinks

FRICTION CHUCK FOR GEAR BLANK FACING OPERATION

The simple chuck shown in the accompanying illustration has proved to be a very convenient device for holding gear blanks while facing one side after having turned and bored the blank and faced the other side in a preceding operation. Referring to the illustration, the friction chuck or arbor *A* is made from a piece of steel having a diameter about 1/4 inch greater than the bore in the gear blank. In making the arbor, the first step is to true up the piece of steel *A* in the lathe chuck and turn the end to a push fit in the bore of the gear blank. A flat, as indicated in the end view, is then filed on the turned portion without loosening the chuck jaws. This flat must be made just deep enough to admit the roller between the gear blank and the arbor.

When the blank is pushed on the arbor and the roller inserted, a slight turn of the blank will cause it to become locked on the arbor by the wedging action of the roller.



Friction Chuck for holding Gear Blank while facing

After the facing operation has been performed, the blank is released by turning it back to its original position. A piece of emery cloth placed over the turned surface will enable the workman to obtain a good grip on the work. Much less time is required in chucking the work when the friction type of chuck is used than when the work is mounted on an arbor between lathe centers. If a friction arbor of this type is used frequently, it is well to have it threaded so that it can be screwed on the lathe spindle.

Navarre, Ohio GEORGE R. CASTER

CUTTING ECCENTRIC SLOTS IN A CAM-PLATE

Some time ago the writer had occasion to machine a cam-plate like the one shown at *C* in the accompanying illustration. The eccentric slots at *D* and *E* were approximately 1 3/8 inches wide and 6 inches long and were cut entirely through the cast-iron plate, which was 1 3/8 inches thick. The limited tool equipment in the shop where the work was performed necessitated the finishing of the slots by hand or in the lathe. After laying out and rough-drilling the castings, the work was set up in the chuck *A* of a large lathe and the shaping of the slot by means of a rigid boring tool commenced, the reciprocating motion being obtained by means of a lever attached to the rear of the chuck. The operation of this lever by hand proved a tedious job that would have taken some time to complete, so the idea was conceived of imparting the oscillating movement to the chuck by means of an adjoining lathe.

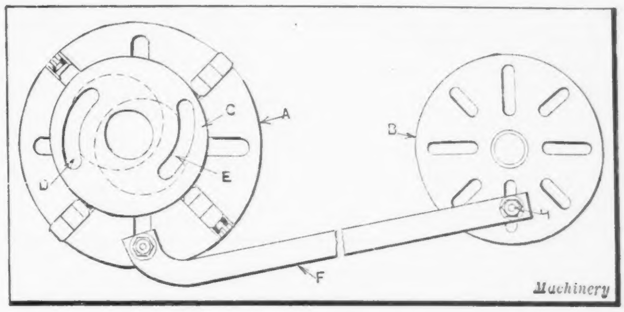


Diagram illustrating Method of shaping Eccentric Cam Slots

The faceplate *B* of the adjoining lathe, which was nearly in line with the chuck of the large lathe chuck *A*, was provided with a bar *F* of the required length and shape to permit it to impart an oscillating movement to the chuck *A*. The final adjustment for the length of the stroke required in machining the sides of the slots was obtained by changing the position of stud *H* in the radial slot of faceplate *B*.

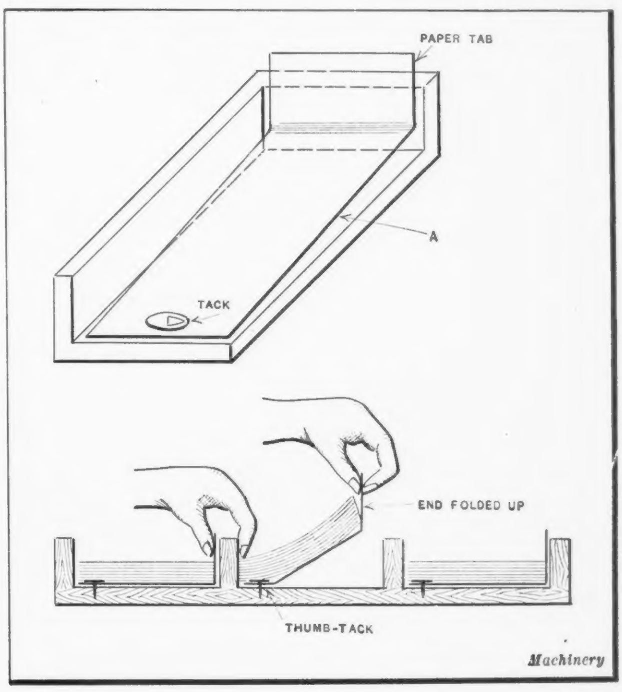
JIM HENDERSON

METHOD OF FILING TRACINGS

Difficulty in removing tracings from compartments in files may be eliminated by providing each compartment with a lifting tab made from paper and arranged as shown in the accompanying illustration. The piece of drawing paper or other heavy paper used for the lifting tab should not be quite so wide as the compartment, and should be long enough to extend the full length of the compartment and up one side to the top of the partition.

The vertical or bent up end of the paper can be grasped between the thumb and finger, as shown in the lower view, and used to raise the whole stack of tracings, drawings, or prints. The inner end of the paper tab should be secured to the bottom of the drawer with a thumb tack so that it will not slip or pull out when the bent up end is lifted.

Buffalo, N. Y. A. B. CASPER



Tracing Compartments provided with Lifting Tabs

SPECIAL MILLING OPERATIONS

Two interesting milling operations are shown in the accompanying illustrations. The information relating to these operations has been obtained from the production service department of the Kearney & Trecker Corporation, Milwaukee, Wis. A form milling operation on wrench jaws that requires the use of an interesting design of clamping fixture, is illustrated in Fig. 1. The V-type fixture used is designed to hold thirty-two wrenches, each half of the fixture being arranged to hold two rows of eight wrenches each. While sixteen wrenches are being milled in one half of the fixture, the operator reloads the other half. The milling machine used is equipped with a power rapid traverse, and the fixture is mounted on a 17-inch rapid indexing table. Between cuts the fixture is withdrawn from beneath the cutters by the power rapid traverse, and then the quick-acting index table is used to rotate the fixture and locate the opposite end in the milling position.

The index table is designed so that the operator with a single movement of his left hand, disengages the index plunger and unlocks the table, his right hand being free to swing the table around. The index plunger is automatically held out of engagement until just before the table reaches its new position; it is then tripped by a dog and snaps into place without any attention on the part of the operator. The left hand of the operator still grips the lever, which is now returned to the clamping position.

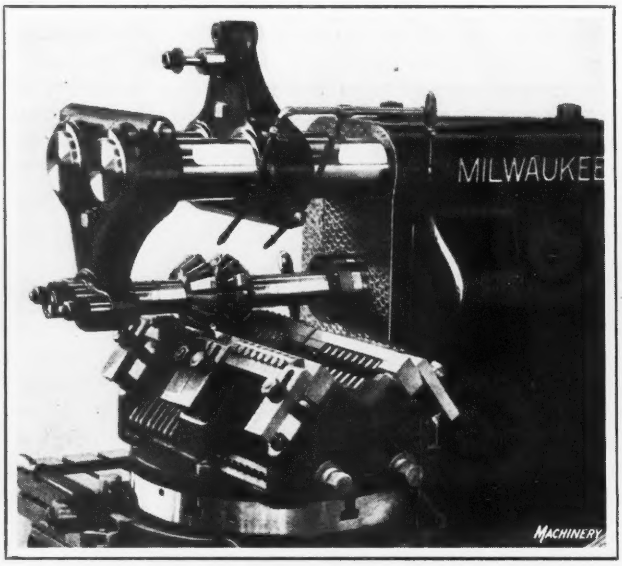


Fig. 1. Form Milling Operation requiring Unusual Design of Fixture

The accuracy of these wrenches requires that each milled jaw line up with a previously drilled hole. Accordingly, the wrenches are placed on a series of hardened pins, each pin entering one end of the hole in the wrench. To save clamping individually, the thirty-two wrenches are held down by four clamp blocks, each block containing eight hardened pins backed by heavy spring plungers. Clamping against spring pressure provides for slight variations in the work.

Each clamp block is guided by two large pilot pins, there being one pin at each end. After being guided into position, each clamp block is held down firmly by two slip clamps. These slip clamps, as shown, have a slot down the center through which passes a fulcrum bolt. A spring on this bolt holds the clamp up during unloading. Underneath the slip clamp at the outer end is a hardened pin which is raised or lowered by an eccentric cross-shaft with a nut on the outer end of the fixture. Turning one of these nuts raises the two pins, fulcrums the slip clamps, and forces the upper clamp block carrying the eight pins, down on the wrenches.

The two high-speed steel formed cutters used are 5⅜ inches in diameter and have a speed of 56 revolutions per minute. The depth of the cut is 1/16 inch, and the total length 2¼ inches for each cutter. The feed is 3 inches per minute, and the production 500 pieces per hour. It will be noted that the inverted arbor pendant serves as a truss between the double over-arms tying them rigidly together. This operation is an example of high-production milling on a standard manufacturing type of milling machine.

A special feature of the operation illustrated in Fig. 2 is the use of spiral slab mills in connection with rotary milling. This combination insures clean-cut edges and eliminates the burring operation which was necessary when a face milling cutter was employed. The pieces to be milled are car seat tracks which are made of very tough cold-drawn steel. The machine is equipped with a standard 17-inch rotary table and a fixture that holds six pieces arranged in two rows. Three fixed serrated studs are located between each pair of inner and outer pieces. The clamping bolts on the outer end of the fixture close the inner and outer jaws simultaneously, drawing the two pieces against the central studs and equalizing the clamping pressure. By substituting different clamps, several sizes of tracks having six different radii may be accommodated. The right- and left-hand spiral mills used are 3 inches in diameter and 6 inches long. The speed is 204 revolutions per minute, and the feed 14 inches per minute. The depth of cut is 3/32 inch and the width of each track 1⅝ inches. This fixture increased production from 30 tracks per hour to 80 tracks per hour, in addition to eliminating the burring operation.

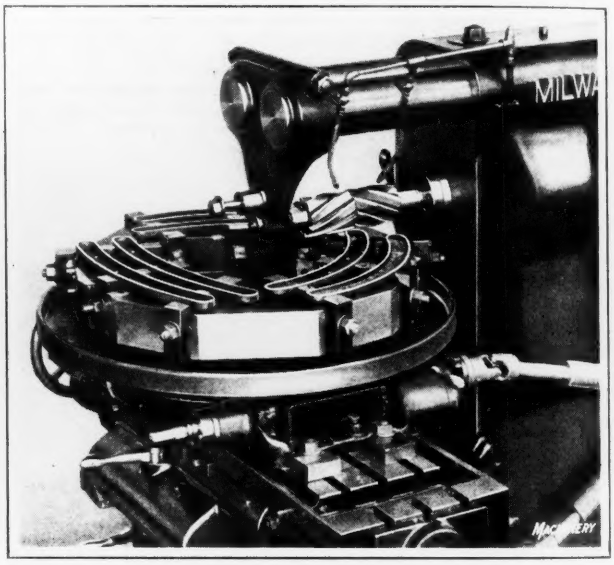


Fig. 2. Use of Spiral Slab Mills in Conjunction with Rotary Milling

* * *

MEETING OF AMERICAN WELDING SOCIETY

Oxygen formed the subject matter of the papers read before the American Welding Society at the meeting held February 16 at the Engineering Societies Building, New York City. John J. Crowe, engineer in charge of the apparatus research and development department of the Air Reduction Sales Co., New York City, read a paper, illustrated with lantern slides, entitled "Some Experiments with High Purity Oxygen." The results of these experiments, which have been conducted over a long period, showed that the purity of oxygen is of great importance in the economy of the use of the cutting torch. The amount of oxygen required for cutting decreases, according to Mr. Crowe, materially as the purity of the oxygen increases. It was stated, for example, that the use of 99 or 99.5 per cent pure oxygen would reduce the oxygen consumption to a marked degree as compared with the use of 98 or 98.5 per cent pure oxygen. F. P. Gross, Jr., demonstrated how the purity of oxygen may be simply tested with a comparatively inexpensive apparatus for commercial purposes, and G. Van Alstyne gave a demonstration of the low temperature and other remarkable properties of liquid oxygen.

Designing Automatic Packing Machinery

By ALBERT A. DOWD

If a machine is designed to manufacture a certain product and the pieces are to be packed in a given way after manufacture, this fact should be considered when designing the machine. When possible, the machine should be arranged to deliver the pieces in a manner that will facilitate packing, even if it is not possible to combine the manufacturing and packing units in the same machine, although this may often be done to advantage. If there are likely to be imperfections in the product and an inspection is required, it would not be wise to consider manufacturing and packing in the same machine. For example, if an automatic machine is used in manufacturing the small brass bushing *A* shown in Fig. 1, the breakage or dulling of the tool which turns the diameter *C* might leave the portion *B* unfinished, and a number of defective pieces might be turned out without the fact being discovered for some time. The inspector would, of course, find these even if the operator of the machine did not look for them and set them aside; but if they were packed in a box, without inspection, the defects would not be evident until received by the customer. Another point that must be considered is the possibility of the packing unit breaking down, which might hold up production considerably.

Often a dozen or more machines are operating on the same kind of product, and while one may break down, the others continue, and in many cases one packing machine will take care of the product from those that remain in operation. When a packing machine breaks down, hand packing may be resorted to until it has been repaired. If the product is likely to be troublesome, due to possible variations in size or for other reasons, it is better to design separate machines for different packing operations. The pieces shown at *D* and *F* are examples of products that cause trouble in packing. The part at *D* is a molded form which may have rough projecting surfaces *E* at various points on the circumference. The part at *F* is also molded and has fins at *G* and *H* where the mold is parted. In each of these pieces, the rolling action would be interfered with by these defects, and if handled through chutes, the rough edges of the pieces might cause them to stick, unless allowance were made in the design to prevent this trouble.

If automatic machinery is required that will fill a bottle with pills, cork, seal, and label it, ready for the consumer, we must first decide whether it is advisable to attempt to do all these things in one machine, or whether it would be better to make separate units for the various operations. If a machine is designed to perform all the operations, a breakdown of one unit would delay the production greatly and might also cause considerable waste or damage before being discovered. It is sometimes difficult to decide upon the most economical method, because so much depends upon the product and the number of operations required. Simple machines for one operation only are favored by some designers, while others believe it more economical to have one machine perform as much work as possible, providing it with suitable safeguards to prevent trouble from variations in the pieces, breakage, etc.

Automatic Shut-off

The principal cause of breakdowns in automatic packing machinery is the variation in the size of the pieces handled. A box may be too large to pass through a magazine or may stick in the carrier; a bottle may be broken; a piece of cardboard or paper may be torn or wrinkled, thus causing it to feed unevenly and clog up the machine; or many other things may happen to prevent the proper functioning of the mechanism. The designer must always think of what may happen to the machine or the product when something goes wrong. If a container is broken so that it will not hold the product, the latter may run out on the floor or into the

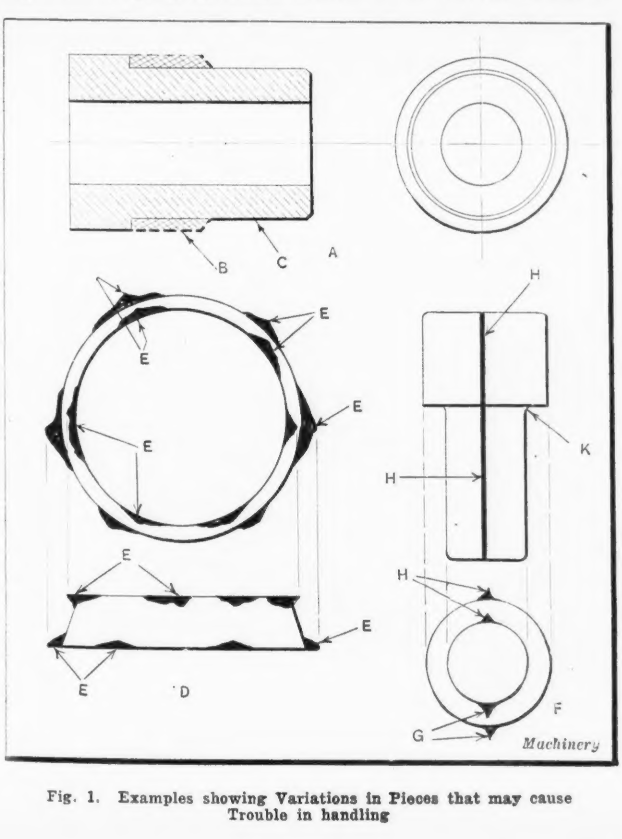


Fig. 1. Examples showing Variations in Pieces that may cause Trouble in handling

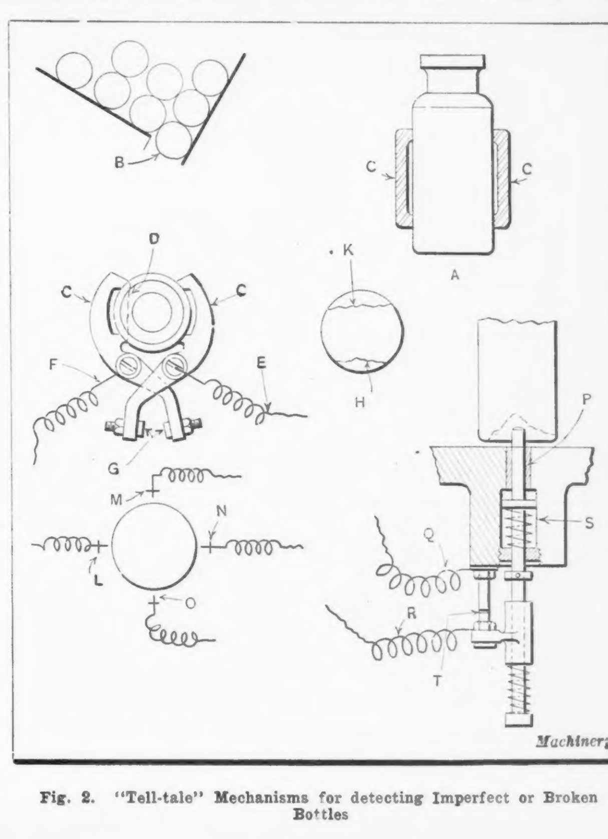


Fig. 2. "Tell-tale" Mechanisms for detecting Imperfect or Broken Bottles

working parts of the machine and cause a lot of trouble. When several items are being handled, such as pills, boxes, covers, etc., the failure of any one unit to function properly usually wastes a good amount of the product and interrupts production. Experienced designers keep these points in mind and endeavor to arrange automatic shut-off devices or ejectors which will operate when any given part of the mechanism fails to function.

To illustrate the importance of automatic shut-offs, let us refer to Fig. 2. The bottle *A* is to be filled with pills or tablets. We are not concerned with anything at present except the bottle, but as this is made of glass it is assumed that one may be broken occasionally during transit through the machine. Should this occur, we would like to prevent it from causing machine breakage or loss of product. If the bottle is fed from a tray through an opening, as shown at *B*, into or on a receiving table of the indexing variety, it will be necessary to hold it firmly on the table in one way or another. Spring fingers are often used in combination with a plunger which forces the bottle into position. In this case, gripping fingers are used, which fit the sides of the bottle as shown at *C*. With a design of this kind, it is desirable to provide a device that will either reject a broken machine. In combination with the points for the outside of the bottle, a spring plunger *P* could also be used to detect any break in the bottom. It is unnecessary to give a detailed description of this, as the idea will be understood almost at a glance. The two connections are shown at *Q* and *R*, and a light spring at *S* forces the plunger upward, causing a contact at *T* under certain conditions. It is not usually advisable to make an ejecting device unless the product is very easily handled and a new piece can be immediately put into the carrier without interrupting production. It will usually be found better to stop the machine entirely although sometimes a warning bell can be used instead to notify the operator that something is wrong.

Another example that illustrates how defective work may cause trouble in an automatic machine is shown in Fig. 3. The fiber strip *A* was to be fed through a machine and wound with resistance wire. The pieces of fiber were cut by machinery to exact length, but the ends were sometimes ragged and frayed, as shown at *B*. The thickness *C* of the frayed portion is considerably greater than the normal thickness *D*. As a result, when the piece was fed into the carrier, the end of the fiber sometimes stuck and was folded back as shown at *E*. This would not pass through the machine

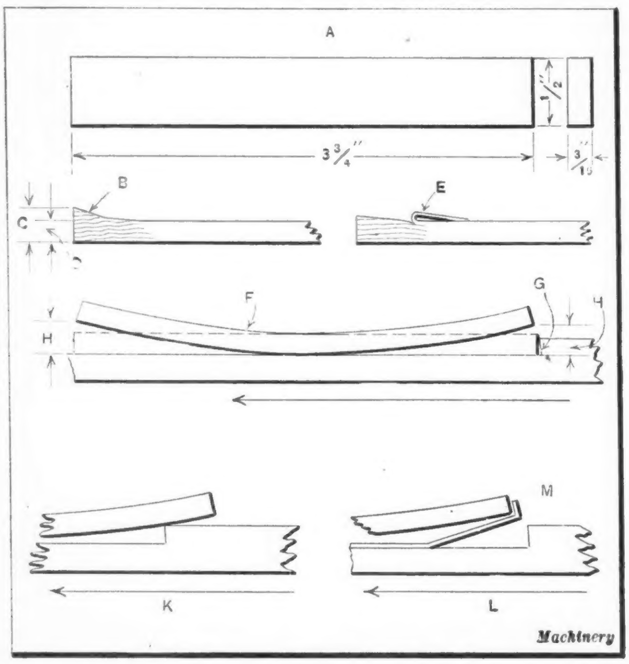


Fig. 3. Warped Fiber Strips that caused Trouble in feeding

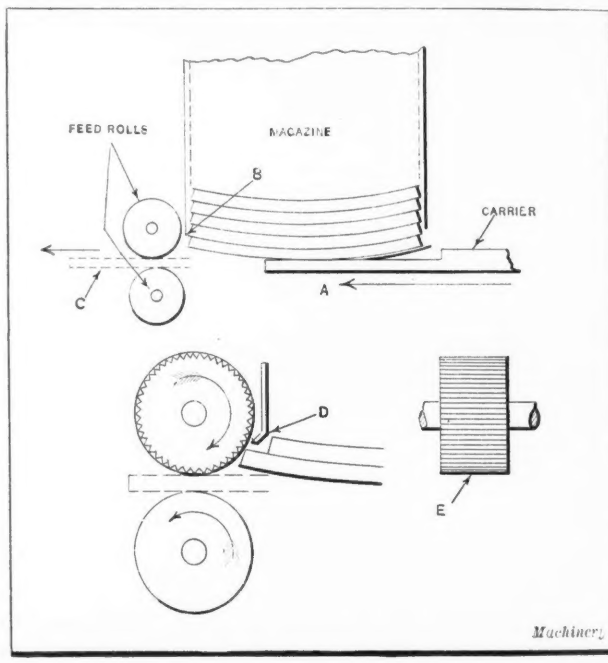


Fig. 4. Improved Feeding Mechanisms that proved satisfactory

bottle or stop the machine when one is encountered. Of course, no broken bottles should be put into the feeding tray, but the continual movement of the mass may cause breakage now and then.

The sides of the bottle are normally gripped by the carrier fingers *C*, so that if one side should be broken as at *D*, the fingers would come closer together. The wires *E* and *F* can be connected in such a way that if the fingers close in to a certain point, as they would do in this case, an electrical contact would be made between the points *G*, thus stopping the machine immediately. It is not difficult to make a device of this kind, but it would not always fulfill the requirements, for if the bottle were broken on both sides, as at *H* and *K*, and lay in the same position with respect to the gripping fingers, they would still grasp the bottle in the regular way and the machine would not stop. It is therefore evident that we must provide a device for detecting a broken bottle which will strike a number of points on the surface.

A much safer way would be to pass each bottle through an automatic electrical inspection device, having a number of points arranged as at *L*, *M*, *N*, and *O*, which would normally be forced by light springs against the bottle. If the plungers should drop into a broken place, they would move forward far enough to make a contact and shut off the machine.

on account of its thickness, so that the wire became badly tangled. Difficulty was also caused by many of the pieces being curved, as shown at *F* in exaggerated form. The carrier which removes the pieces from the magazine had a shoulder at *G* adapted to receive the piece when in normal form. The curvature of the pieces often brought the end above the bottom of the feeder a distance *H* so that the carrier passed completely under the pieces as shown at *K*.

An obvious remedy for such conditions is preliminary inspection of the pieces and rejection of those that are imperfect. In this case, however, such a procedure was undesirable. In order to overcome the trouble, a flat spring was applied to the carrier, as shown at *L*, and by bending the end *M*, a hook was formed which pulled but one piece at a time from the magazine.

Fig. 4 shows at *A* the general arrangement of the magazine, carrier, and feed-rolls. When straight pieces were used in the magazine, they were pulled forward by the carrier under the edge of the cowl *B* and between the feed-rolls, as shown by the dotted lines at *C*. The curved pieces, however, lay in such a position that they would not pass under the cowl, and although this was bent to the form shown at *D* in the enlarged detail, the feed-rolls, being smooth brass, did not grasp them readily and they came through "out of time" with the rest of the mechanism. By taking

out the rolls and knurling them with a straight knurl as at *E*, sufficient roughness was produced to make them function properly when placed in position again. In this instance, the designer was blamed for the trouble encountered, which seemed unjust, as the samples furnished him were straight, and when straight pieces were used the machine gave entire satisfaction. It was probably an instance of this kind that once led someone to remark facetiously that "we ought to make automatic machines out of rubber so they would adjust themselves to variations in the product."

There is only one solution to the problem, and that is to make the design flexible enough to handle parts having a stipulated variation and have these sizes specified in the contract, so that if trouble is caused by over-size pieces, the designer is protected, while the user of the machine must see to it that his product is kept within the required limits of accuracy. Molded pieces are much more likely to cause trouble than those that have been machined or fabricated, both on account of seams and fins and also because shrinkages are not always uniform, due to variations in the composition of the material.

Several years ago, a machine handling disk-shaped tablets *A*, Fig. 5, which had previously been satisfactory, suddenly began to stick and clog up and give a great deal of trouble. The exigencies of the war had made it necessary to make certain changes in the composition of the tablets so that they did not shrink as much in drying as the ones made from the previously used mixture. Hence, although made in the same moulds, the diameter *B* was often too large to permit the tablet to pass through the feed. Also, the pieces were rougher and did not slide through the chutes as rapidly as before, sometimes sticking in transit so that it was necessary to stop the machine and push them through with a long stick. As a result the packages came out only partly filled and entirely unsaleable. The trouble was so serious that the machine was stopped completely and hand packing again resorted to while changes were made in the machine to suit the new conditions. Hundreds of thousands of pieces had been made and these could not be scrapped, nor could production be stopped while new molds were made.

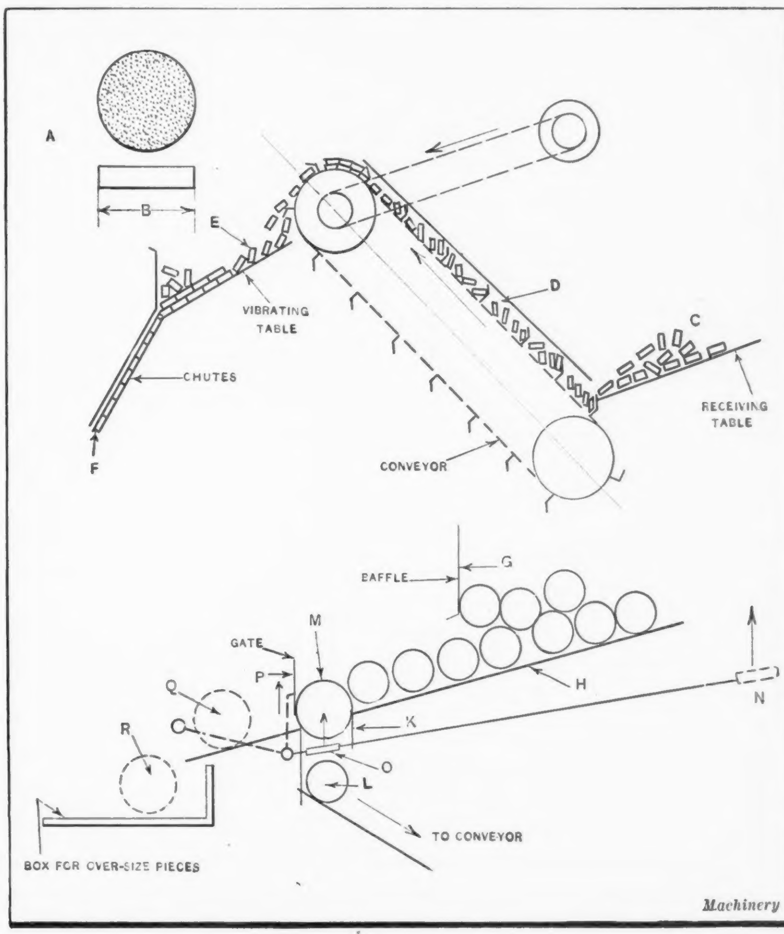


Fig. 5. Equipment for separating Over-size Pieces from the Regular Product

Hand packing in this case was very slow and expensive. The designer suggested that the molds be changed as soon as possible and that, in the meantime, some simple changes be made in the machine. The important parts of the mechanism affected are shown in Fig. 5. The pieces were originally dumped on a receiving table, as shown at *C*, and from this point they were picked up by a conveyor and carried upward at an angle, as at *D*, and dropped on the vibrating table at *E*. From here they were separated and turned in the proper position so that they would fall down the chutes as shown at *F*.

The trouble was overcome by placing an operator in charge of the receiving table and making a few simple changes. The baffle plate *G* was first put in place and another inclined plate set on edge, as shown at *H*. The operator spread the pieces out by hand so that they rolled rapidly down the inclined plate *H* one after the other. An opening was provided through the plate at *K* and all pieces not over-size dropped through to the conveyor as shown at *L*. Occasionally a large piece would drop into the opening at *M* but would not pass through on account of its size. The operator would then pull upward on the lever *N* which caused the finger *O* to come up through the inclined table and push the piece *M* out of the slot at the same time opening the gate at *P*. This allowed the piece to roll down as shown at *Q*, into the box at *R*. It was found that many of the pieces went through the slot to the conveyor without difficulty and that the trouble was mostly caused by a comparatively few over-size pieces. One operator managed to attend to the device without interrupting the production, and although it was a makeshift arrangement, it gave excellent results while it was in use. As soon as the new molds were completed, it was removed and the holes in the receiving table plugged up. These examples are sufficient to illustrate the trouble often caused by imperfect pieces.

In handling castings made from several patterns, a few castings from each pattern should be measured in order to find the maximum and minimum size. An additional allowance sufficient to take care of contingencies should then be made. When fragile material is being handled, try to imagine what may happen if some pieces are broken, and provide for such a condition in the best way possible. Sometimes it is possible to pass pieces that are likely to vary through an automatic gaging device before they are put into the machine. This arrangement is much better than to use a device that will stop the machine when an over-size piece is encountered. Friction devices are often used to prevent breakage when something sticks in the machine, particularly in connection with feeding mechanisms, that are mechanically driven.

An interesting principle that can be adapted to the automatic selection of spherical pieces or balls is shown in Fig. 6. A number of different sizes are fed one at a time through a selection hopper into a suitable trough set at a slight angle so they will roll down it easily. If the balls continue to roll on guide plates *F* and *G*, which are farther apart at the lower end than at the top they will fall through when they reach a point corresponding with their diameters, as at *H*, *K*, and *L*. By placing boxes underneath these

points or by leading chutes away from them, the pieces can be carried to any point desired, by gravity. A principle similar to this can often be applied to prevent oversize spherical pieces from passing into the machine. It is usually better to have separate machines for grading and packing.

There is nothing much easier to handle than a spherical ball or pill, for it will roll on a very slight incline and the pieces are not likely to lodge or cause trouble in feeding. An automatic machine is frequently required that will fill bottles or boxes with various kinds of pills or tablets. Generally a certain number must be placed in the package. In the example shown in Fig. 7, 100 pills of the form shown at *B* are to be placed in each bottle, and the production is required to be not less than 30 bottles per minute. Assuming that the machine movements take one second, we cannot reasonably allow one second for the filling operation. If we were to attempt to arrange 100 pills in line, the distance *A* from one end to the other would probably vary quite a little, and also it would be difficult to arrange the pills in one row and repeat the operation every two seconds. The matter of feeding the pills is the simplest part of this problem, as they would easily roll through chutes that dump into any kind of hopper, as shown at *C*. It is not difficult to put 25 pills into a bottle in one second, and so if we can arrange to fill four bottles simultaneously, the production requirements will be met. In this case, the bottles are carried successively under four spouts *D*, *E*, *F*, and *G*. Each spout is kept full by the hopper and shut-off devices placed at *H*, *K*, *L*, and *M*, allow just 25 pills to pass through when they are operated. The rod *N* can be connected to all the

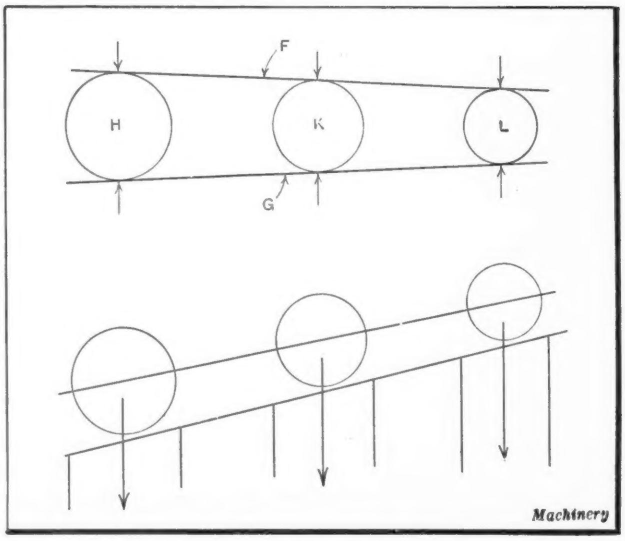


Fig. 6. Diagram showing Method of separating Spherical Pieces of Different Sizes

levers so they will operate in unison. The stations of the machine are naturally spaced the same distance apart as the spouts, and as the bottles move in the direction of the arrow *O*, there is always one under every spout. The first receives 25 pills which fills it up to point *P*; at the same time the others are filled up to *Q*, *R*, and *S*, respectively. By timing the machine to operate every two seconds, one completely filled bottle will be produced in this length of time.

Oval tablets, such as those shown in Fig. 8, nearly always cause trouble in handling. They are sometimes made as shown at *A* with straight edges, while others are made like example *C* with the edges rounded. The method of handling in either case is approximately the same. In attempting to feed tablets of this sort in chutes of the form shown at *B* and *D*, it might appear that they would readily arrange themselves as shown at *F* in the diagram at *E*. As a matter of fact, however, they will frequently lodge as indicated at *H* in diagram *G*, the two spherical surfaces overlapping each other. Therefore it is out of the question to use this form of chute for such pieces.

By using a form like that shown at *K*, the piece will roll on the cylindrical portion *L* without difficulty, but it is not easy to place them in this position in the chutes by any of the methods previously described. In the diagram *M* the piece *O* may lodge on the edge of the chute and it may be made to fall by vibration in one of the directions indicated by the arrows. In the diagram *N*, the chutes are made wider so that the piece *P* will topple over and take position *R*; or moving in the other direction, as shown at *Q* it will fall into the chute on that side. Experiments with the

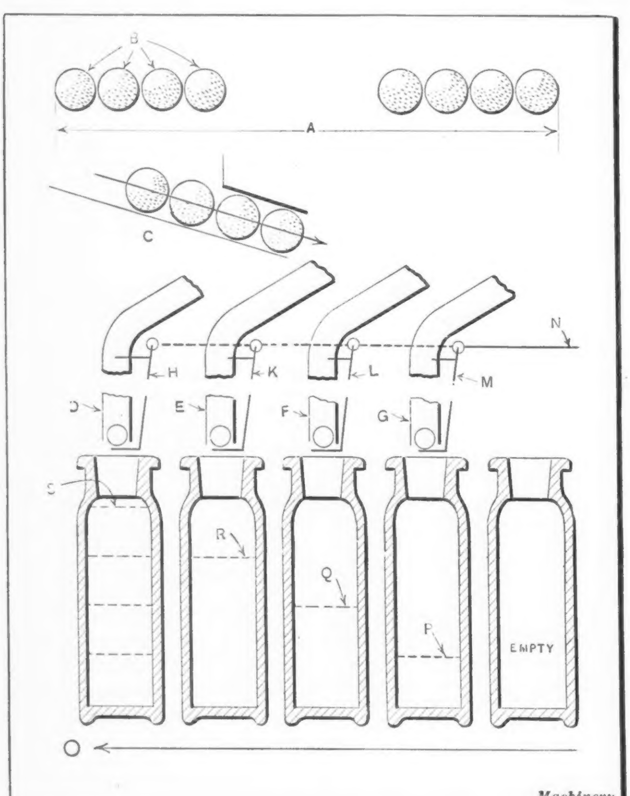


Fig. 7. Filling Bottles in Station-type Machine

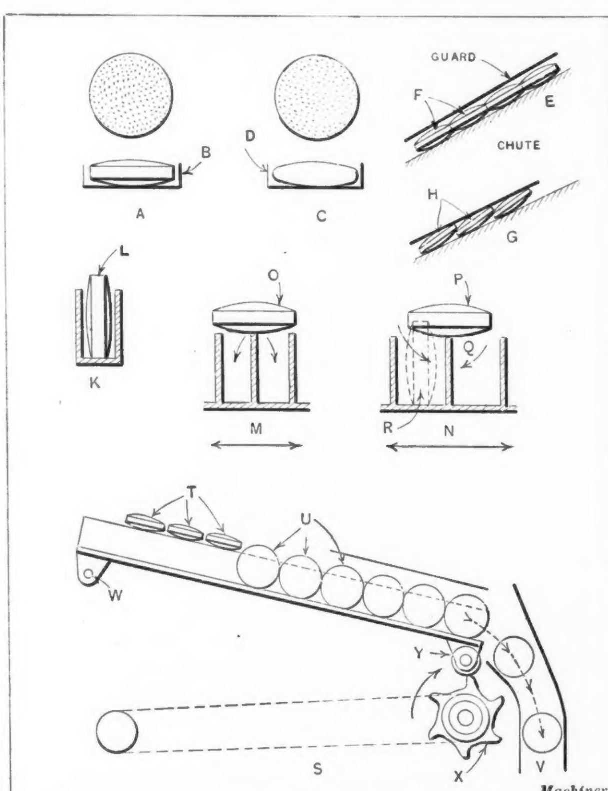


Fig. 8. Method of feeding Oval-shaped Tablets

ordinary form of vibrating plate have shown that such a device is not dependable at all times. The one shown at *S*, however, can be used successfully in practically all cases of this kind. The series of chutes arranged in the form shown at *M* is made into one unit with as many partitions as may be required. By pivoting this group at the point *W* and allowing the other end to hang freely an excellent vibrating effect can be obtained by the action of the agitator *X* on the roll *Y*.

As the chutes swing from point *W*, pieces that lies as at *T* receive less movement at this end, while those further down the chute, as at *U*, are agitated more briskly. As a result, the pieces *T* fall over slowly and drop into the chutes as they go along down the incline, and those at *U* move more and more rapidly, finally dropping off into the receiving chute *V*. It is not possible to specify the angle at which the chute must be set, as this must be determined by experiment. The pivot point *W* may also be placed part way down the incline instead of at the end to produce a somewhat different effect. The product may be very smooth or quite rough, and this point makes a great difference both in the angle used, the pivot point, and the drop of the agitating member *X*. The speed of the latter may be adjusted to meet requirements.

* * *

SOLVING TRIGONOMETRICAL PROBLEMS WITH A PROTRACTOR

By CHARLES KUGLER

The use of a protractor, machinist's scale, and depth gage, as shown in Fig. 1, for solving trigonometrical problems was devised by the writer for cases where extreme accuracy is not required. However, the method is sufficiently accurate for a large per cent of regular machine shop work, and is employed with great satisfaction by many machinists who have been instructed in its use.

Referring to the diagram at the top of Fig. 2, let it be assumed that we are to find angle *S* of a right-angle tri-

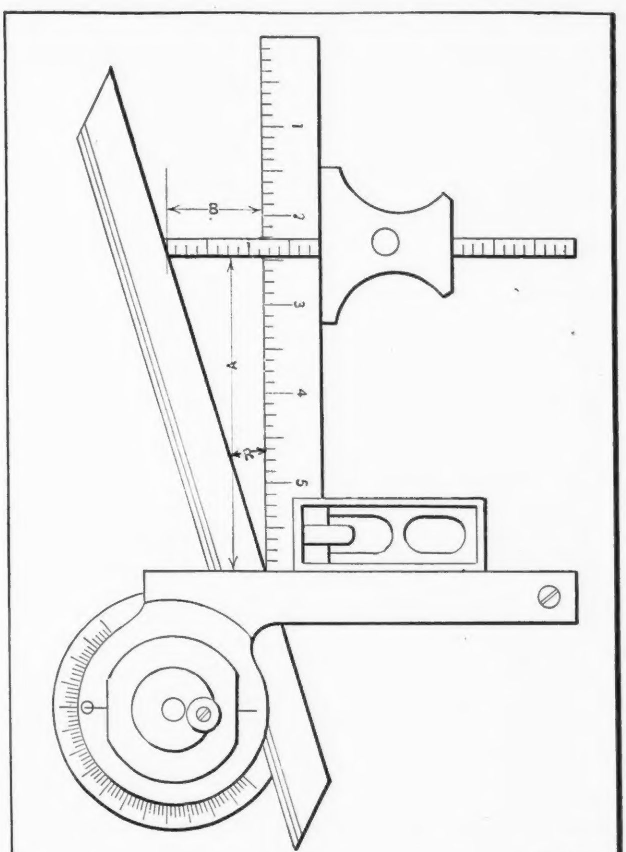


Fig. 1. Method of using Protractor and Scales in solving Trigonometrical Problems

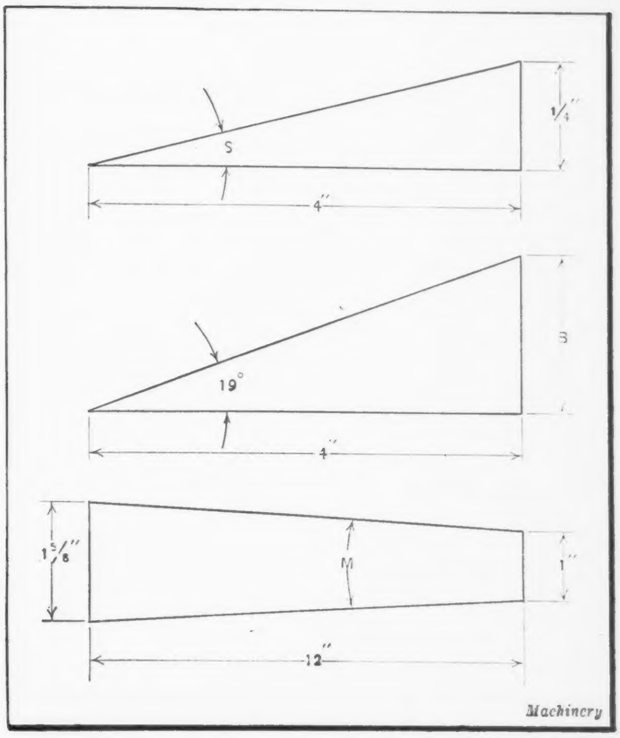


Fig. 2. Diagrams illustrating Problems solved by using Protractor and Scales as shown in Fig. 1

angle having a base of 4 inches and a height of 1/4 inch. For this problem we would set the protractor and the scales in the position shown in Fig. 1, making the dimension *A* equal to 4 inches, and the dimension *B* 1/4 inch. The value of angle *S* could then be read directly on the protractor scale.

If we are to find the dimension *B* indicated in the central diagram in Fig. 2, we would first set the protractor so that angle *R*, Fig. 1, would be 19 degrees and the dimension *A* 4 inches. The height *B* could then be read on the depth gage scale. Referring to the diagram at the bottom of Fig. 2, we will assume that it is required to find the included angle *M* when the taper per foot is 5/8 inch. In this case the taper in 6 inches would be 5/16 inch, and we can, therefore, make dimension *A*, Fig. 1, equal to 6 inches. Dimension *B* could then be made to equal 5/16 inch. The angle *M*, as read directly from the protractor scale, is found to have a value of about 3 degrees. If the included angle is given and the taper per foot is desired, the protractor is set to the included angle, the dimension *A* made to equal one foot after which the required taper per foot will be indicated by the dimension *B*. When a 6-inch scale is used, dimension *A* may be made 6 inches, in which case the result *B* will equal one-half of the required taper per foot.

* * *

HONING OR LAPPING MACHINES FOR AUTOMOBILE CYLINDERS

By W. E. WARR, Moline Tool Co.

In the article "The Automotive Industry and the Machine Tool Builder" in October, 1924, MACHINERY, reference was made on page 87 to honing or lapping machines for automobile cylinders. The inference from the statement there made is that there is no such machine available on the market, and in order to correct this impression it should be mentioned that the Moline Tool Co., Moline, Ill., has built such a machine for the last two years, the machine having been described in August, 1923, MACHINERY, page 993. Doubtless those readers who did not see the description might be interested in it. From the article that appeared in October MACHINERY, it is evident that there are some equipment engineers in the automotive field who are not familiar with this machine.

The Machine-building Industries

MOST of the industries producing goods for direct consumption are active. In many instances, when business does not seem satisfactory to the individual manufacturer, the difficulty is not due to lack of "normal" demand, but to excessive manufacturing capacity. That there is nothing seriously the matter with industrial activity is evidenced by the fact that freight movements of merchandise have for some time past been the largest in history. An examination of the various indexes of business activity, as compiled by the Federal Reserve Bank, shows that business in general continues to improve; but it must be remembered that the present business recovery has not been uniform. Some industries have gone ahead more rapidly than others, while in some of the basic fields, like the textile industry, the improvement is, as yet, slight.

Orders for Future Needs are Placed with Great Caution

It is pointed out that a marked feature in the present upward swing of business is the policy of wholesalers and dealers, as well as manufacturers and retailers, to buy for current requirements only. Orders for future needs are placed very conservatively. Even in the face of advancing prices, this appears to hold true in all lines of industry. The two main reasons for this condition are stated to be the present efficiency of transportation, which insures quick deliveries, and the lesson taught by the sudden change from a boom to a depression in 1920, when both manufacturers and dealers were caught with excessive stocks and inventories that had to be disposed of at a loss. The policy of conservative buying has been an important factor in checking any tendency toward a boom in business, with its attendant inflation.

It has been expected that the building activity would fall off somewhat during the present year, but there appears to be no indication of such an abatement. Building permits in 180 cities of the United States are continuing to show an increase, although there is now no appreciable national building shortage.

The Machine Tool Industry

It is now possible to record a definite improvement in the machine tool industry. There has been a steady increase in orders since last November, and the average of unfilled orders in the hands of machine tool builders is increasing. Some builders of special high-production machine tools show considerable activity, while the demand for the regular standard lines has improved to a lesser degree.

Ernest F. DuBrul, general manager of the National Machine Tool Builders' Association, points out that recent price reductions in automobiles show the effect of excess capacity and the attendant keen competition on price. This situation ought to increase the demand for high-capacity machine tools, because the desire to reduce shop costs should aid the builder of machine tools to sell machinery for replacement in the automobile field.

"The English machine tool industry appears to be operating at a higher rate than our own," says Mr. DuBrul. "Statistics of British exports of machine tools seem to show that a much higher proportion of British production is exported than in our own industry. Recent articles in various engineering and business magazines indicate that the British are carefully studying the foreign market, and that possibly there is more foreign business to be had than American machine tool builders in general are endeavoring to obtain." On the other hand, it must be remembered that the export market for standard machine tools is definitely limited abroad by the competition of English, Swedish, German, French, and Italian builders.

The Small Tool Industry

In the small tool field, conditions are improving. The tap and die industry operates at approximately 75 per cent of what most of the manufacturers in this field would consider a good normal business. The demand for ground thread taps remains steady, but is as yet a comparatively small percentage of the total sales of taps. The present tendency is to make ground thread taps from high-speed steel. The price situation in the twist drill field, which for a couple of years has demoralized the trade, has gradually re-established itself, and prices have now reached a more satisfactory level. One of the recent developments in this field relates to the grinding of wire-size drills, which has not been the practice in the past. In the grinding wheel field there is considerable activity, and the demand is good. In the hacksaw field, again, the situation is very unsatisfactory. Although materials for hacksaws are 50 per cent in advance of pre-war prices and labor is nearly double, hacksaws are being sold at below pre-war figures, stated by some manufacturers to be far below cost.

The Iron and Steel Field

In the iron and steel industry, production continues at a high rate. Steel production averages over 90 per cent of the capacity of the industry. The United States Steel Corporation's ingot production has reached 95 per cent of capacity. The pig iron output is also unusually high, the increase of production in January being 12 per cent over the production in December. The operating rate is now about 10 per cent above the average rate for 1923.

Some doubt has been expressed as to whether this industry will be able to maintain present operations throughout the year. James A. Campbell, president of the Youngstown Sheet & Tube Co., states that prominent leaders are of the opinion that it is possible to maintain a 90 per cent production rate throughout most of the year. There has been a noticeable stiffening of prices, although most of the producers have a sufficient tonnage ahead to carry them through the first quarter of the year. Compared with November 1, steel prices are now from $2 to $4 per ton higher, and some producers have already put into effect a further advance to apply to second quarter business.

The advances in pig iron since early in November have been more pronounced, on the average, than in rolled steel, due to the fact that the big iron market was in a greater state of depression at the time that the revival began. On an average, pig iron prices have increased about $3.50 a ton. There is now less disposition among pig iron producers to raise their prices, and some of them are offering to take second-quarter business at the same prices as those that applied during the first quarter of the year. On the first of February 261 blast furnaces were active, a gain of 23 over January 1.

The Automobile Industry

Automobile production has not reached the high level of a year ago, but is more likely to continue at an even pace throughout 1925, instead of meeting with a slump toward the middle of the year, as was the case in 1924. The attitude in the automobile industry is one of great caution, and every effort is made to prevent the accumulation of large stocks, either in finished cars or parts. The saturation point in the automobile market certainly has not yet been reached, but the requirements for replacements are smaller than past statistics indicated that they would be. This is due to the steady improvement in the quality and the consequent longer life of cars.

New Machinery and Tools

The Complete Monthly Record of New Metal-working Machinery

Cleveland Multiple-spindle Automatic

A 1½-inch four-spindle automatic screw machine designated as "Model M" has recently been added to the line of machines of this class built by the Cleveland Automatic Machine Co., Cleveland, Ohio. From the front view shown in Fig. 1, it will be seen that a liberal amount of space has been provided between the tools and the chip pan to receive chips. Furthermore, when the space directly under the tools has been filled, any further accumulation is deflected by an inclined surface inside the bed at the top of center legs *A*, so that the chips slide into the compartment at the right-hand side of these legs. Door *B* gives access to a cabinet in which the spindle speed-change gears can be stored. Seven speed changes ranging from 210 to 751 revolutions per minute are provided for, the gears in use being contained in case *C*. All gears on the machine are fully enclosed to safeguard the operator from injury.

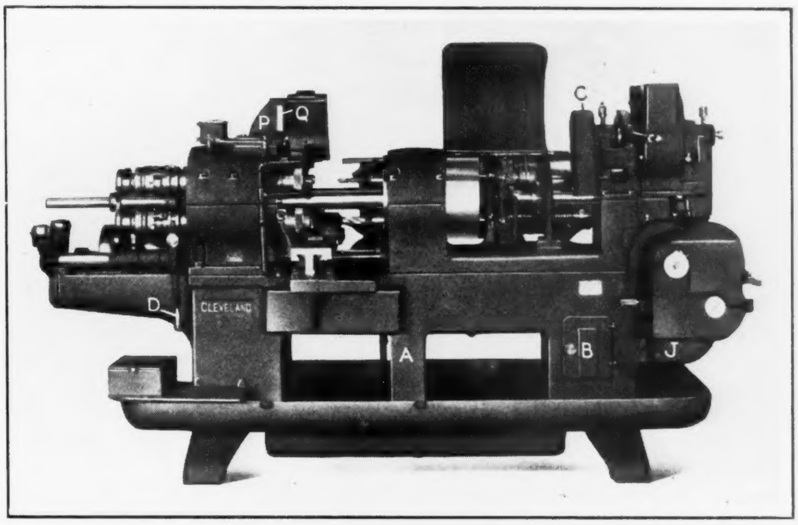


Fig. 1. Cleveland Four-spindle Automatic Screw Machine

Quick changing of chucks has been made possible through the use of a knurled steel guard screwed on the spindle turret which can be readily removed by hand. This guard prevents dirt and chips from getting into the spindle mechanism. Compression collars are provided on the spindles to take care of variations in the size of materials. The spindle bearings consist of hardened steel bushings mounted in the spindle turret housing and bronze bushings pressed on the spindles. Any wear in the front spindle bearings can be compensated for through an adjustment, and spindle end motion can be taken up by means of a nut located at the back of the spindle gears between the spindle housing and the chuck-operating thimbles.

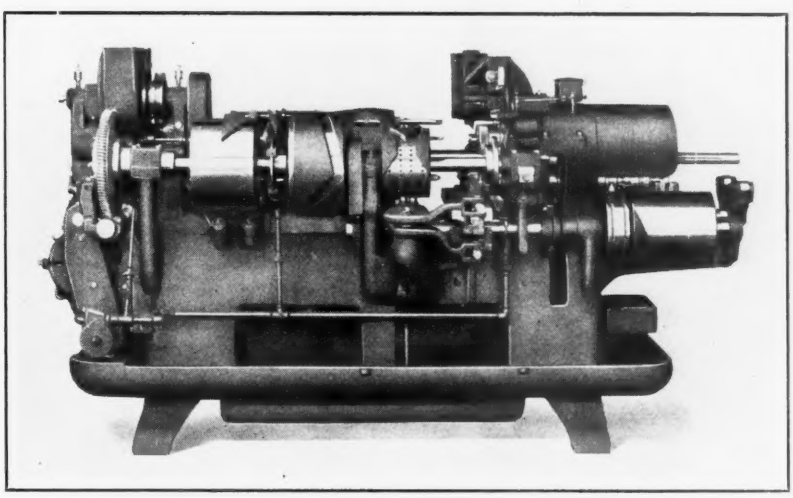


Fig. 2. Rear View, showing the Arrangement of the Camshaft and Other Mechanisms

A convenient feature of the machine is the design of lever *D*, which is used for opening and closing the chucks. When it is required to put a new bar of stock into a chuck, or to release a chuck for any other reason, the lever is swung on its pivotal support into a horizontal position so as to make the rear end enter the space between two flanges on the chuck-operating thimble. Then the hand-lever is swung sideways to open the chuck. In stocking up the machine, the spindle turret is indexed to bring the spindles successively into the position where they may be engaged by this hand-lever.

High and Low Speeds of Operation

This automatic is equipped with a high-speed mechanism for effecting the indexing movements, and a low-speed feed for controlling the working movements of the machine. Two complete sets of gears are used for accomplishing the two movements. The high-speed movements are obtained through a mechanism that functions as follows: Power from the driving pulley *E*, Fig. 3, is transmitted through bevel gears and a vertical shaft to a second pair of bevel gears *F* and then through spur gears *G* to a worm meshing with worm-wheel *H* on the feed camshaft. These high-speed gears are always running, but when an indexing movement has been accomplished, clutch *I* is automatically tripped by the adjusting pins on the face of worm-wheel *H* to prevent further transmission of power through this high-speed driving mechanism.

The low-speed drive for the feed movements is taken directly from the spindle-driving gears, and as a result, all feed movements, as expressed in inches per spindle revolution, remain constant regardless of how the spindle speed may be changed. From the gears in case *C*, Fig. 1, power is transmitted through gearing to a vertical shaft, at the lower end of which there is a worm meshing with a worm-wheel in case *J*. From this worm-wheel the drive is delivered through either of two pairs of selective sliding gears *K*, Fig. 3, to a cone of spur gears *L*, and then through an intermediate gear controlled by lever *M* to a cross-shaft which carries ratchet *N*.

Like the high-speed drive, this low-speed drive runs continuously. When the high-speed drive is thrown out, a spider secured to the back of the lower one of bevel gears *F* automatically stops and allows ratchet *N* to engage the pawl. The low-speed movement then becomes effective and transmits power to the worm meshing with the feed worm-wheel *H*. Ten feed changes are available by engaging tumbler gears with cone gears *L* through the manipulation of lever *M*. Gears *K* have a ratio of 2 to 1, and are engaged by lever *O* to give the ten feeds in combination with the five gears comprising cone *L*.

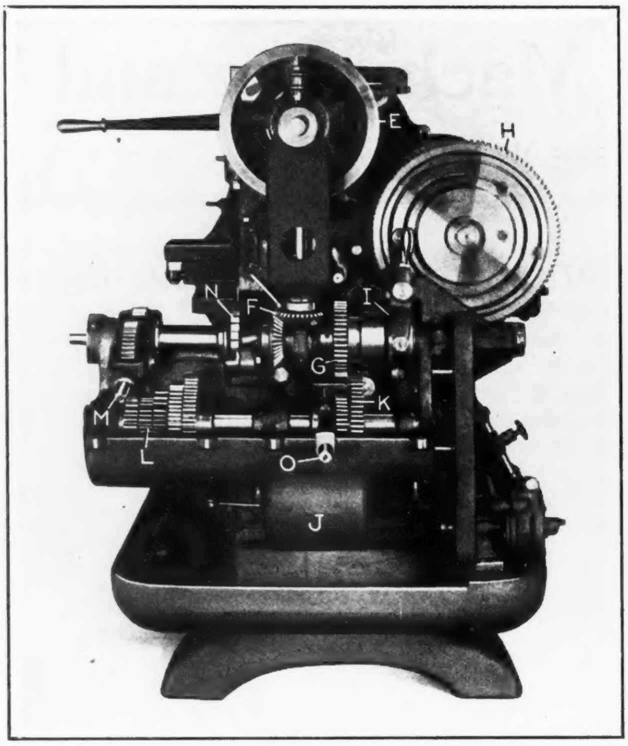


Fig. 3. Right-hand End of Cleveland Automatic, with Guards removed to show the Various Gears

From Fig. 2 it will be seen that the camshaft runs along the back of the machine, where all cams are accessible for adjustment, accessibility being one of the features claimed for this machine. This applies not only to the camshaft but to all mechanisms, a case in point being that the gear guards are so arranged that they can be quickly removed.

Considerable attention has been paid to lubrication. Oil is delivered from the pump by individual tubes directly to the tool points, which eliminates the use of pipes above the turret. The oil-tubes are of the telescopic type, and move back and forth as the tools advance toward or recede from the work, with the result that the delivery of oil is always at the tool point. This feature is especially important in the case of the threading spindle because, by carrying the oil right through the spindle and delivering it to the center of the die, the oil accomplishes the double purpose of lubricating the chasers and of washing out chips. When the die-spindle is not required, a bracket and auxiliary gearing can be added to permit the die-spindle and auxiliary reaming spindle to be used for high-speed drilling.

The machine is furnished with both roughing and finishing slides, as well as a cut-off slide. The finishing slide is carried by the bracket *P*, Fig. 1, which is bolted to the work-spindle turret housing. The cam action on sliding plate *Q* is so placed as to eliminate any chance of vibration from forming operations. It is connected direct by a roll attached to the side of the finishing slide. Many features of design incorporated in the Cleveland single-spindle automatic have been applied to this new four-spindle machine.

The machine has a capacity for handling 1½-inch round stock, 1¼-inch hexagonal stock, and 1 1/16-inch square stock, the diameter of the turret holes being 1½ inches. The maximum length of feed is 8 inches, and the maximum milling length, 6 inches. The distance from the turret face to the face of the chucks may vary from 7 11/16 inches to 13 11/16 inches. The machine may be equipped with either an individual motor drive or a belt drive. When an individual motor is employed, it should be of 10 horsepower capacity, of the constant-speed type, and run at about 1800 revolutions per minute. The floor space occupied is 116 by 42 inches.

BROWN & SHARPE MOTOR-IN-THE-BASE MILLING MACHINE

Compactness has been attained in a new milling machine placed on the market by the Brown & Sharpe Mfg. Co., Providence, R. I., by providing a compartment in the base for

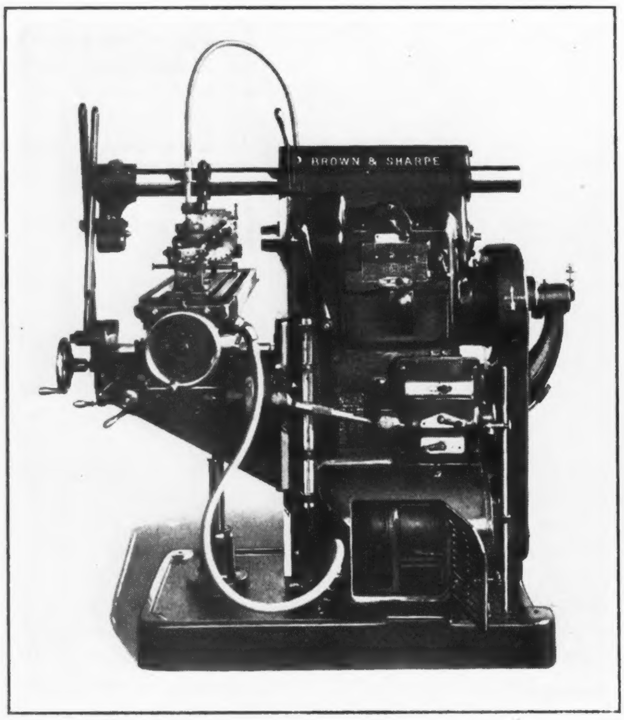


Fig. 1. Brown & Sharpe Milling Machine with Motor located in a Base Compartment

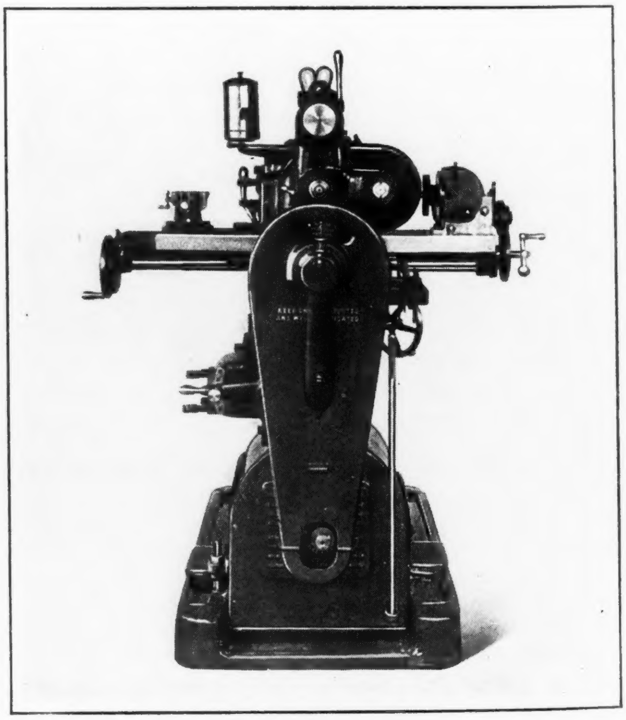


Fig. 2. Rear View of Machine showing the Cast-iron Guard furnished for the Driving Chain

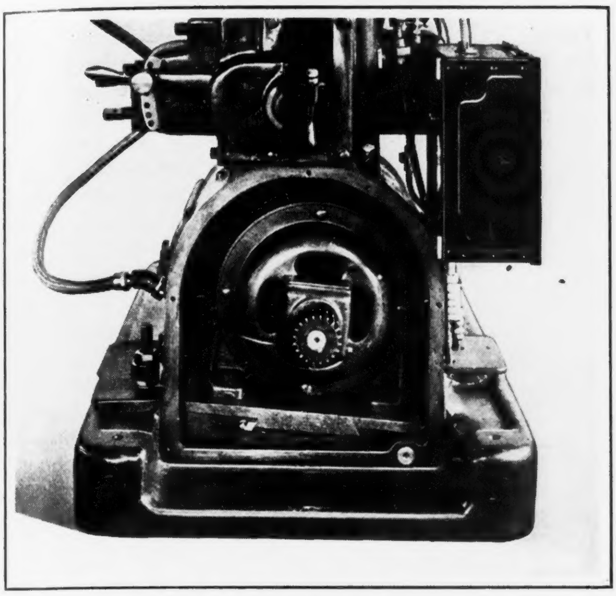


Fig. 3. Manner in which Motor is installed in the Base Compartment

installing the motor. The machine is built in three universal and three plain sizes, and can be arranged for a belt drive when a drive of this type is preferable. The general design does not differ materially from the well-known B & S column-and-knee type milling machine, with the exception of the construction necessary for the motor drive. Thus, the important change comprises a redesigning of the lower part of the column to provide the motor compartment. The column and base is a one-piece casting with a solid top cast over the motor compartment. In this way, complete protection is furnished the motor from oil, cutting lubricant, chips, dirt, etc.

Ample provision has been made to insure a sufficient circulation of air for the motor, three ventilators being located on the sides and rear of the compartment. These ventilators serve a twofold purpose in that they also permit ready access to the motor for lubricating, adjusting, repairing, and cleaning. Oil wells are fastened to the frame of the motor, as may be seen in Fig. 1, and these are readily accessible through the door on the right-hand side of the machine. The wells are connected by tubes to the motor bearings to permit a quick means of lubricating these parts.

In order to facilitate installing and removing the motor and to provide an adjustment for the driving chain, the motor is mounted on an adjustable base which is separate from the column and base casting. This base is hinged on the right-hand side, as shown in Fig. 2, and is provided with an angular adjustment which is regulated by means of the bolt on the outer left-hand side of the column. The bed of the motor is tongued, and slides in a groove in the hinged base, to which it is firmly held by means of a gib. A tank for cutting lubricant, which is also located in the base, extends forward around the foot of the elevating screw. Strainers are set in the top of the base through which the oil drips back into the reservoir.

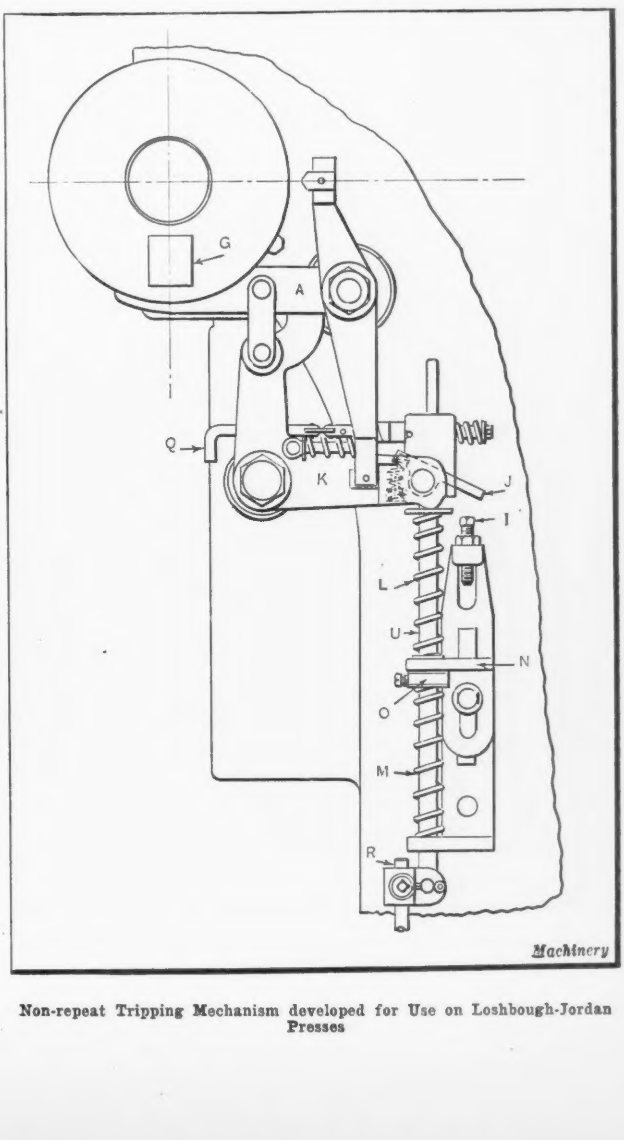
A feature of the machine is the ease with which the friction driving clutch can be adjusted, this clutch being mounted on the main drive shaft within the driving pulley or sprocket. The adjustment can be readily made after removing the small plate on the side of the pulley, which is accessible through an opening in the chain guard, as may be seen from Fig. 2. The No. 3-B plain machine is regularly supplied with a pump, and all other machines, both plain and universal, can be equipped with one.

Adequate protection is furnished for all moving parts, the driving and driven sprockets and the driving chain being fully enclosed by a cast-iron guard. Complete access to the motor compartment is obtained by removing the chain guard, chain, and the rear wall of the compartment. When the machine is belt-driven, the motor compartment is available for storing tools and parts.

LOSHBOUGH-JORDAN NON-REPEAT TRIPPING MECHANISM

In many power press accidents, the operator claims that the press repeated its stroke even though the foot-pedal was not held down. To eliminate all doubt on this point, the Loshbough-Jordan Tool & Machine Co., Elkhart, Ind., has brought out a non-repeat tripping mechanism that is applicable to all power presses built by the company. On a press equipped with this mechanism, the pedal can be held down as long as desired without the press repeating, because it is necessary to allow the pedal to return to the extreme upright position before the press can again be tripped. When it is desirable to run a press equipped with this non-repeat tripping mechanism continuously, it is simply necessary to turn a lever to the right or left and thus disconnect it.

The manner in which the tripping mechanism functions will be understood by referring to the accompanying illustration. In setting the machine to guard against a repeating stroke, lever *Q* is pointed downward as shown. Set-screw *I* is then adjusted so as to cause lever *J* to release rod *U* when lever *K* has been drawn downward to a point where latch *A* will clear clutch pin *G* just enough to allow the clutch pin to engage the flywheel. Set-screw *I* is then locked permanently by tightening the lock-nut. (Lever *K* is drawn down as mentioned by applying pressure on the foot-pedal). Bracket *N* is next adjusted to produce just enough tension on spring *L* to return lever *K* to its extreme upright position as shown, after which collar *O* is adjusted to place just enough tension on spring *M* to return pedal rods *R* and *U* to their extreme upright positions. When it is desired to operate the machine continuously, it is only necessary to give a half turn to lever *Q* so that it will point upward. This change can be made while the punch press is in operation.



Non-repeat Tripping Mechanism developed for Use on Loshbough-Jordan Presses

SCHELLENBACH MULTIPLE-DIAMETER STOP

Turning tools on engine lathes, screw machines, and similar machine tools can be accurately stopped at predetermined transverse positions of the tool-rest by employing a stop recently developed by W. L. Schellenbach, Rawson Bldg., Fourth and Elm Sts., Cincinnati, Ohio. This stop is intended primarily for use in turning work of a multiple number of diameters. The design is such that the tool-rest can be positively stopped, regardless of whether it is being moved toward the back or the front of the machine, and it is so securely locked into place by opposing members that any backlash in the cross-feed screw cannot affect the position of the tool. The housing of the device is shown at *A*, Fig. 1, applied to a standard engine lathe, and its construction will be readily understood by reference to Fig. 2. It can be attached to any lathe without altering existing parts.

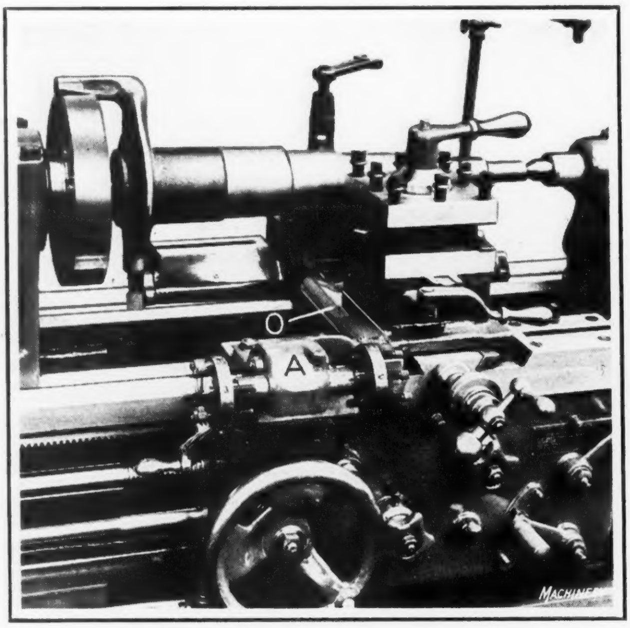


Fig. 1. Schellenbach Multiple-diameter Stop applied to a Standard Engine Lathe

The housing *A* is secured to the top of the lathe carriage by bolts that engage T-slots in the wing of the carriage. Fastened to the lathe cross-slide by means of dowel-pins and screws, is a nut *B*. A driving screw *C*, of coarse lead, engages this nut, and hence rotary motion is transmitted to the screw by an in or out movement of the cross-slide. On the forward end of screw *C* is a miter pinion which drives a similar pinion on shaft *E*, the latter being mounted at right angles to the driving screw. The two miter gears are held in engagement by tightening up screw *F* against which the left-hand end of shaft *E* abuts. When screw *F* is loosened and withdrawn by applying the toolpost wrench, the miter gears separate and the device becomes inoperative. Screw *C* then rotates idly as the cross-slide is moved back and forth.

Pinned to shaft *E* is a spur gear *G* which meshes with pinion *H*, the latter being splined to a revolving shuttle *J*. This shuttle is threaded and engages stationary nuts in housing *A*; consequently, the rotary motion delivered to the shuttle through screw *C*, shaft *E*, and the gears, when the cross-slide is moved horizontally, causes the shuttle also to move endwise within the housing. This endwise movement is about one-half that of the cross-slide. Mounted on shaft *K* at the front of housing *A* are two disks *L* that are each provided with stop-screws which may be set for limiting the movement of the shuttle, and consequently of the cross-slide, to suit the different diameters to which the work is to be turned. A spring-seated ball *M* is engaged with grooves in shaft *K* to hold the selected screws of either disk in alignment with a screw *N* in each end of the shuttle. Screws *N* are provided with threads of fine pitch so that they may be accurately adjusted. Such an adjustment is made when the tool has been removed for grinding, and permits a duplicate setting of the tool for each step in the operation without adjusting all the screws in the disks. In Fig. 1 it will be seen that a cover *O* pro-

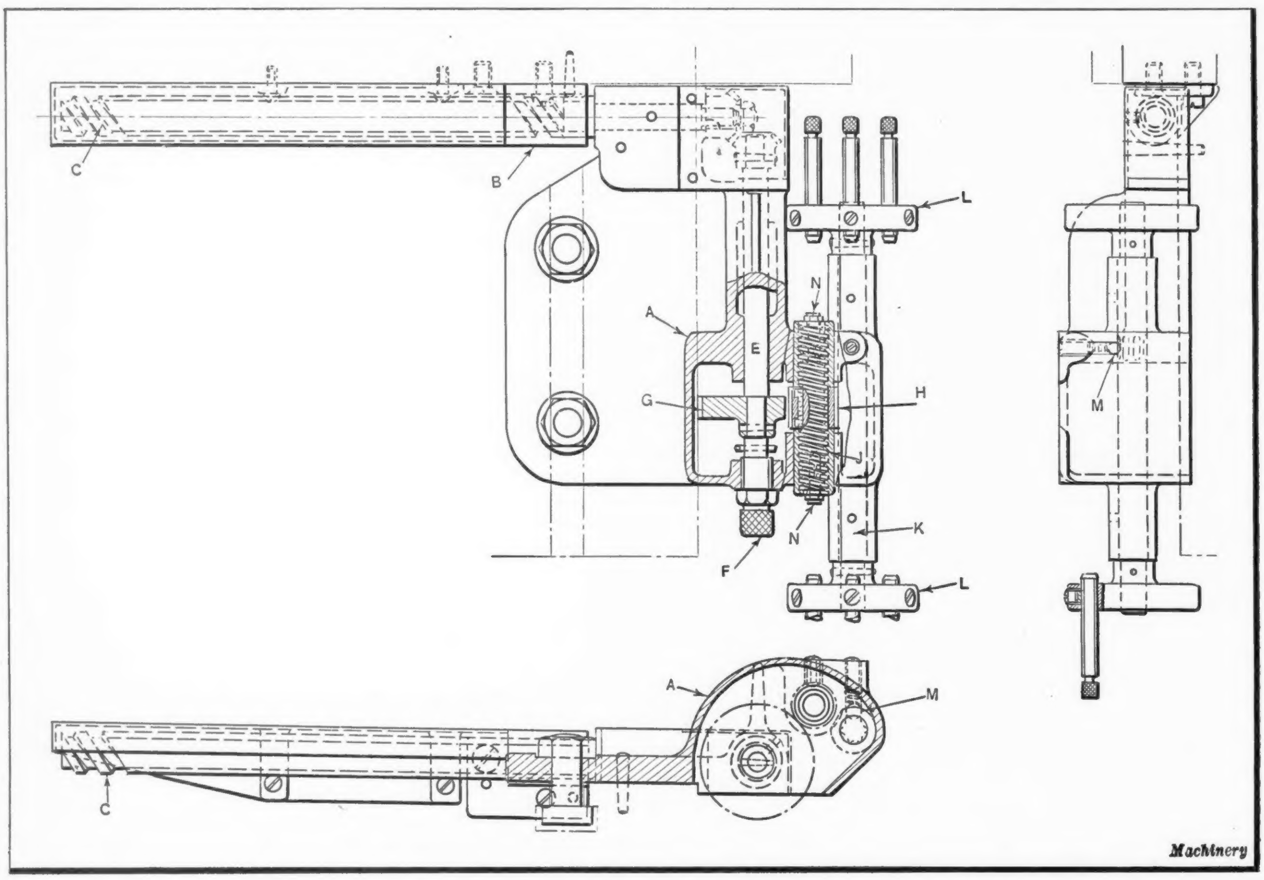


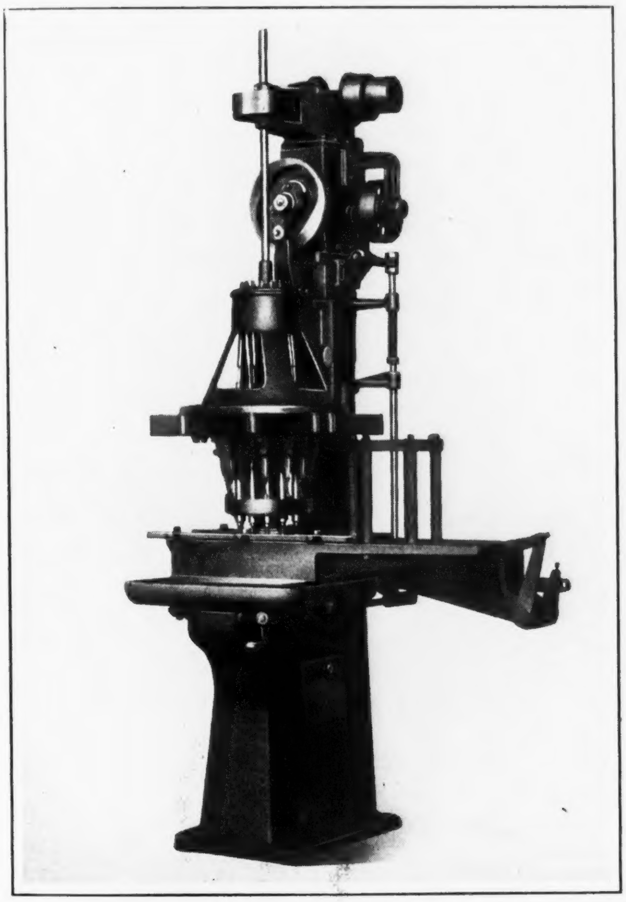
Fig. 2. Construction of the Multiple-diameter Stop, which is Applicable to Lathes, Screw Machines, etc.

tects screw *C*, Fig. 2, from chips and dirt. Covers also protect the miter pinions.

In operating a lathe equipped with this device, the operator may readily see the graduations on the micrometer dial of the regular cross-slide feed-screw and use them to check the accuracy of the stop. It is stated that the device has proved so sensitive in actual practice that the cross-slide can be stopped by merely holding a finger against one of the screws *N*. Work can be turned to a number of diameters accurate within a thousandth of an inch.

"NATCO" AUTOMATIC MULTIPLE-SPINDLE DRILLING MACHINE

A multiple-spindle drilling machine in which the head is fed automatically by means of a cam has recently been developed by the National Automatic Tool Co., Richmond, Ind. This No. 11C machine compares in size with the No. 11 standard hand-feed machine built by the same company. It

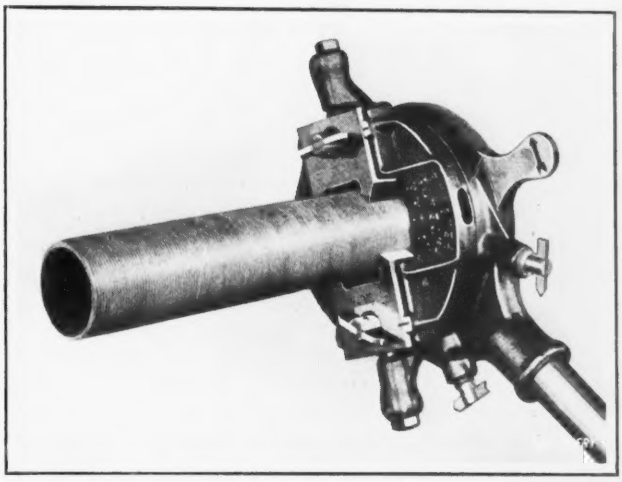


"Natco" Multiple-spindle Drilling Machine equipped with an Automatic Cam Feed

may be furnished with 12-inch round heads, arranged with twelve or sixteen spindles, or with a 24-inch sixteen-spindle straight-line head.

The cam by means of which the automatic feed is obtained is of the plate type with a track that actuates the head through a roll. This roll is mounted on a bracket bolted to the top of the head, and thus raises and lowers the head as the cam revolves. The cam driving mechanism is contained in a gear-box interposed between the top of the column and the overhead casting. Control of the feed is accomplished through the crank located at the front of the table. By setting this crank to suit, the machine may be run continuously or stopped at the end of the return stroke.

This machine is particularly adapted to high-production counterboring, countersinking, and drilling operations where a light, quick-acting machine is essential. The standard work-table supplied with the No. 11 machine is furnished, and either a belt or motor drive.



Reed Ratchet Pipe Stock which can be used for cutting Threads the Full Length of Pipe

REED RATCHET PIPE STOCK

Bolt and pipe threads, both right- and left-hand, of any pitch and of American or British standards, can be cut in all sizes from ½ to 2 inches by means of a ratchet pipe stock recently developed by the Reed Mfg. Co., Erie, Pa. This versatility is attained by employing a die having a double-threaded throat that starts the cutting and draws the tool ahead, thus eliminating the necessity of incorporating a lead-screw in the device. The double thread holds the die tightly on the pipe as soon as the stock is turned. The stock is slid instantly into position on a pipe or bolt and centered by means of four adjustable guides which are operated by a turn of the wrist. These guides slide on the pipe as the die cuts its way along and thus keep the stock centered, even if threads are cut the full length of the pipe. Resettings are not required in an operation of this kind. Another feature is that a die can be replaced in about ten seconds.

GARDNER BALL-BEARING POLISHING LATHE

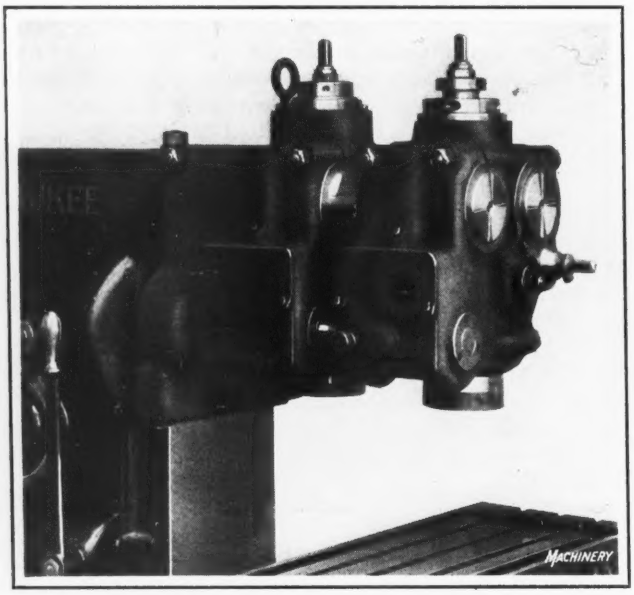
A No. 3 heavy-duty polishing lathe here illustrated has just been added to the line of machines built by the Gardner Machine Co., 414 E. Gardner St., Beloit, Wis. The machine is equipped with ball bearings, and is designed to meet polishing requirements more severe than the average case. The bearing housings extend considerably from the column so as to provide a rigid support for the spindle, this construc-

Gardner Heavy-duty Polishing Lathe

tion being particularly desirable for operations in which it is necessary to use a long spindle. The illustration shows the machine equipped with a spindle of minimum length; longer ones can be furnished to suit requirements.

MILWAUKEE TWO-SPINDLE MILLING HEAD

Considerable work to be milled can be handled best by using two vertical spindles, and for this reason, the Kearney & Trecker Corporation, Milwaukee, Wis., has recently placed on the market for use on all "Milwaukee" milling machines, the vertical head here illustrated. The spindle nearest the column is fixed in its relation to the column, and supported by a housing clamped both to the base of the column and to the double over-arms that pass through it. The spindles themselves are located centrally between the double over-arms to obtain a maximum work range in either direction and a rigid construction. The housing for the outer spindle



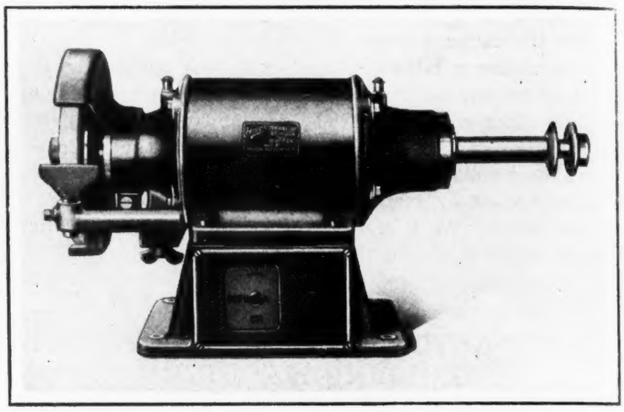
Milwaukee Milling Head equipped with Two Vertical Spindles

is adjustable to and from the column, a screw and micrometer dial being provided for making this adjustment with accuracy. There is also a vertical adjustment for the outer spindle to permit changing the vertical relation between the cutters carried by the two spindles.

It is sometimes desirable to run one spindle in one direction and the other spindle in the opposite direction, and so a reverse drive is provided for the outer spindle, which, in combination with the reverse embodied in the machine, makes it possible to run both spindles in either direction. In using face mills of large diameter with a spindle exactly vertical relative to the table, it frequently happens that the back edge of the cutter drags and mars the surface of the work. To prevent this when using the new attachment, one of the over-arms is passed through an eccentric bushing in the housing. This bushing may be rotated in either direction to tilt the spindle slightly from the vertical and thus avoid the dragging action of the cutters.

HISEY GRINDING AND BUFFING MACHINE

Bench and floor type grinding and buffing machines of improved design are being placed on the market by the Hisey-Wolf Machine Co., Cincinnati, Ohio. Both types are made in ½- and 1-horsepower sizes, and are equipped with alternating- or direct-current motors. The bench machine is furnished with an open type of buffing spindle on the right-hand side as shown, while the floor machine is furnished with an encased spindle extension. With the excep-

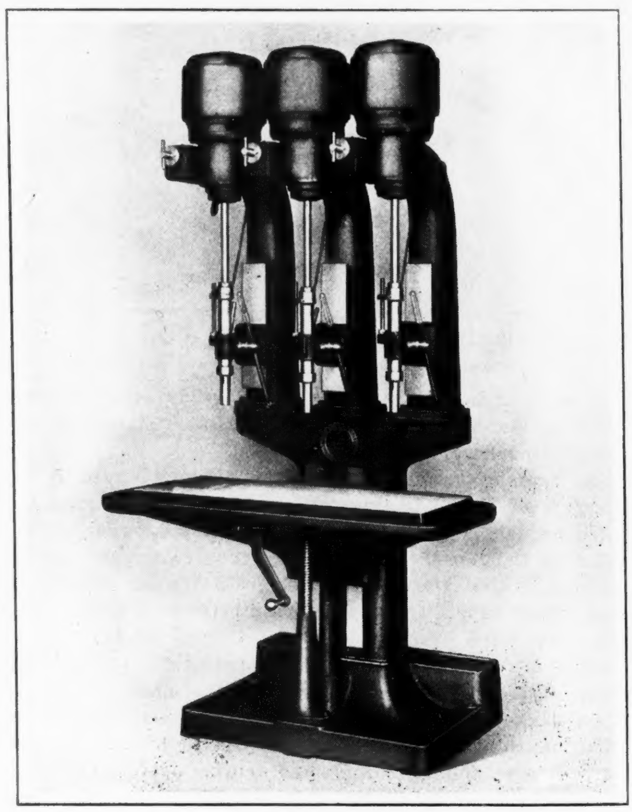


Hisey Combination Grinding and Buffing Machine

tion of the buffing-wheel spindle, the bench machine is similar in design to the two-wheel grinding machine illustrated in November, 1923, MACHINERY. The floor type machine is of the same design as the machine illustrated in August, 1923, MACHINERY, except for the motor starter.

LELAND-GIFFORD "MOTOR-SPINDLE" DRILLING MACHINES

Sensitive drilling machines made with one, two, three, four, or six spindles, and equipped with an individual motor drive to each spindle, are being introduced to the trade by the Leland-Gifford Co., Worcester, Mass. The advantages claimed for the individual drive to each spindle are greater flexibility, and simplicity of design. The motors are of a design in which the rotating member or rotor is of the cast type. There are no wires to become loose in this member. Each motor is mounted on a quill carried on ball bearings, which conveniently solves rotation and lubrication problems. No moving parts are in contact in this motor, and hence its life is said to be practically indefinite, if ordinary care is taken. The motors are intended for operation on 220-volt, three-phase, 60-cycle alternating current, but small transformers are provided for using current of other voltages.

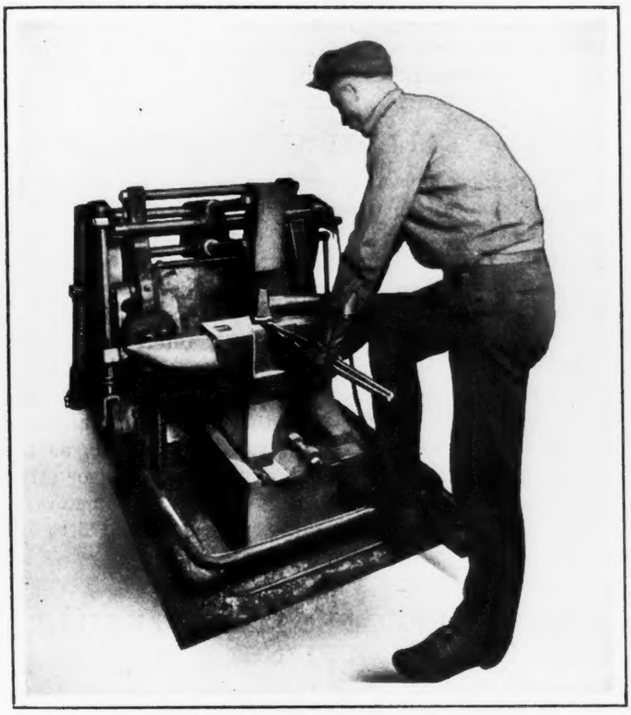


Leland-Gifford Three-spindle Drilling Machine with Individual Motor Drive to Each Spindle

Four motor-spindle speeds of 600, 900, 1200, and 1800 revolutions per minute are obtainable through a specially designed five-position drum type of controller. The operation of this controller is easy, and it plainly shows the speed at which the spindle is being run. In the simplest form, the machines are furnished with a lever feed to the spindles and the four motor speeds, and are arranged for dry drilling. However, the machines are easily adapted to a semi-automatic power feed with back-gears giving four additional speeds to the spindles. Necessary equipment for wet drilling can also be furnished. These machines are built in the usual sizes of 14- and 20-inch swing.

BLACKER BLACKSMITH HAMMER

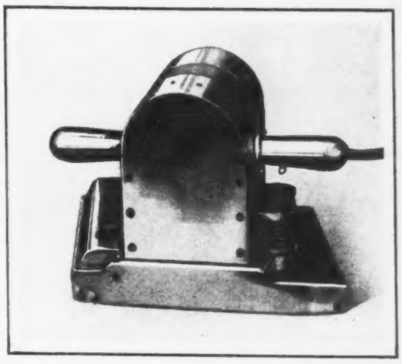
An improved machine equipped with a hammer head that may be traversed over the face of an anvil to facilitate the forging of a large variety of parts has recently been placed on the market by the Blacker Engineering Co., Inc., Grand Central Terminal, New York City. The design of this equipment will be understood from the accompanying illustration. In order to strike the hammer as near the human way as possible, it is raised to the maximum height before each blow. The force and the rapidity of the blows are controlled by a foot-pedal and varied by simply depressing the pedal different amounts. If the pedal is released after a blow, the hammer will remain neutral until the pedal is again depressed. The position of the hammer along the anvil is controlled by a winged foot-lever at the right of the operating pedal. Adjustment of the anvil to and from the machine is effected by means of a set-screw. The machine is intended for use as a helper to the blacksmith instead of as a production hammer, although it can also be used for this class of work.



Blacker Mechanical "Helper" for Blacksmiths

BARKER SANDER AND GRINDER

A portable electric sander and grinder which may be provided with either sand or emery paper for finishing flat wood or metal surfaces is a recent product of R. L. Barker & Co., 642 W. Washington Blvd., Chicago, Ill. The equipment is driven by a 1/3-horsepower universal motor which may be operated on 110- or 220-volt alternating or direct current taken from an ordinary lighting socket. After attaching the device to a socket and turning a switch, work may be sanded or ground by applying a slight pressure to a spring-end handle and pushing the device back and forth over the work. As soon as the operation is stopped, a coil spring raises the drum to which the paper is attached. This drum is dynamically balanced and is operated at a speed of 4000 revolutions per minute. It is 6 inches long and 4 inches in diameter.

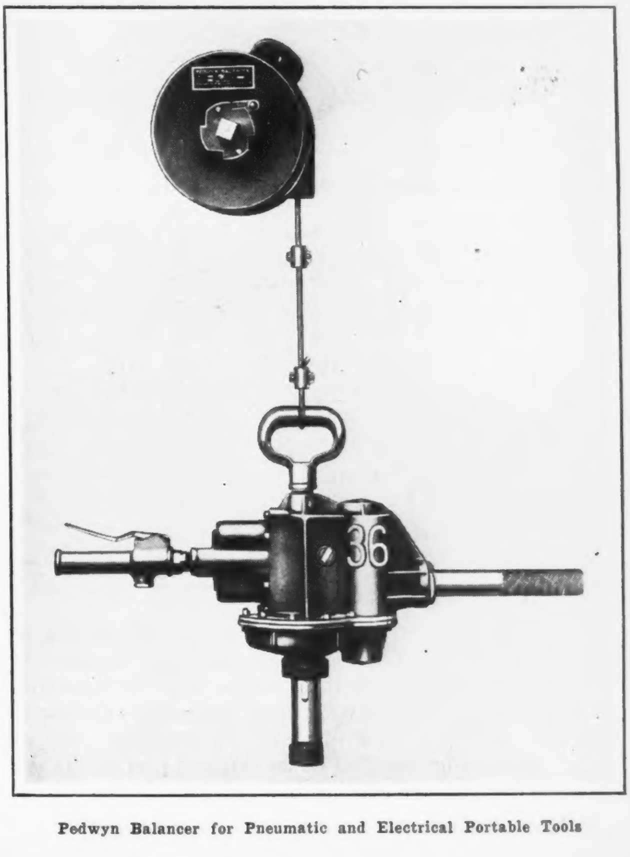


Barker Sander and Grinder for Wooden and Metal Parts

All gears and ball bearings in the device are totally enclosed and run in oil. There is a roller-equipped base for guiding the machine over the work. Between this base and the power unit in the upper housing, is a screw adjustment for accurately controlling the depth of cut, as well as a spring that relieves the pressure of the drum on the work in finishing. A cover retains the dust.

PEDWYN PORTABLE-TOOL BALANCER

A self-contained mechanical device for suspending, balancing, or lifting pneumatic and electric portable tools, is now being placed on the market by the Chicago Pneumatic Tool Co., 6 E. 44th St., New York City. This device is known as the Pedwyn balancer. It eliminates the necessity of using a counterbalancing means for relieving the operator from fatigue in using portable tools. The balancer is also classed as portable equipment, because it can be readily installed in different locations. It can be conveniently mounted on a trolley over a conveyor for traversing the portable tool longitudinally. With this balancer, the danger of breaking drills and grinding wheels by dropping a tool on the floor, is prevented. It is made in two sizes, the No. 1 having a

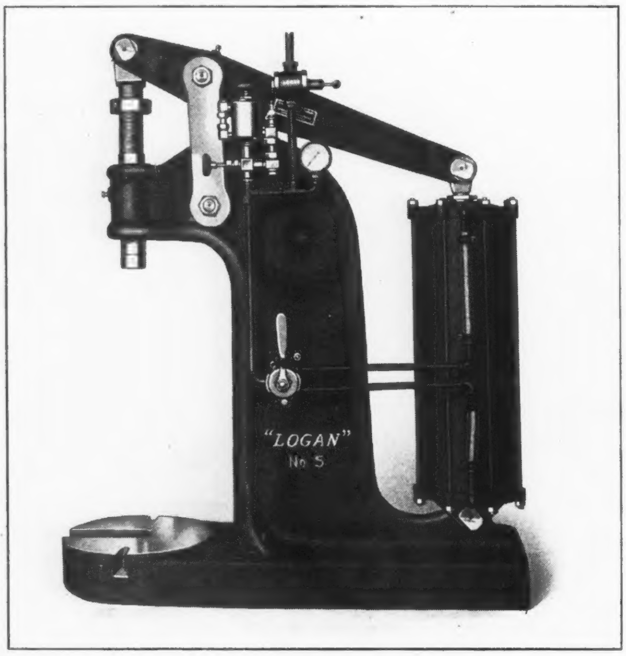


Pedwyn Balancer for Pneumatic and Electrical Portable Tools

capacity for holding tools weighing from 10 to 50 pounds, and the No. 2, for tools weighing from 50 to 100 pounds. Both sizes are readily adjustable to suit any intermediate load within their range.

LOGANSPORT AIR-OPERATED ARBOR PRESSES

Air-operated arbor presses are now being built in six standard sizes by the Logansport Machine Co., 529 Market St., Logansport, Ind. The smallest size delivers a maximum force of 2500 pounds with an air pressure of 80 pounds per square inch, and the largest size, a force of 18,500 pounds with the same pressure per square inch. If an air pressure of 100 pounds per square inch is employed, the maximum force of the largest size is 23,000 pounds. Any pressure up to the maximum may be instantly obtained by operating a reducing valve. The maximum power is obtained through a permanent connection of the lever arm to the cylinder.

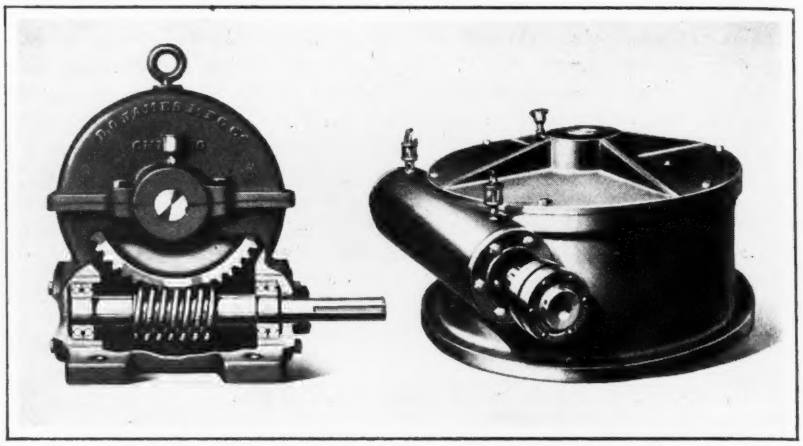


Logansport Arbor Press operated by Air

The machine is especially adapted to such operations as assembling, broaching, bending, forming, forcing, pressing, and riveting parts and compressing metals. Air-expanded cup packings are used for the cylinder piston. When desired, a foot-operated valve can be furnished with this equipment to give the operator free use of both hands in controlling the press and work. All working parts of the air valve and cylinder are oiled by an automatic lubricator. The smallest machine is 19 inches high and weighs about 150 pounds, while the largest machine is 47 inches high and weighs about 650 pounds. Special sizes can be built to suit requirements.

JAMES WORM-GEAR REDUCERS

Worm-gear reducers are being placed on the market by the D. O. James Mfg. Co., 1120 W. Monroe St., Chicago, Ill., in vertical and angle types that may be applied in machine shops in the drives of machines, conveyors, lineshafts, overhead cranes, etc. In direct-driven machines, the reducers can often be installed as an integral part of the machines. The reducers are small and compact and permit the motor to be placed at a distance from the drive itself



Two Styles of James Worm-gear Reducers

when there is danger of steam, gas, etc., spoiling the armature windings. One of the features of these reducers is that all shafts are held in alignment by thrust bearings. The reducers are entirely enclosed and require no attention with the exception of occasional oiling.

GENERAL ELECTRIC HOIST STARTER

A small and compact reversing starter designed particularly for monorail hoist service, but which may be used in numerous other applications, has been brought out by the General Electric Co., Schenectady, N. Y. This starter throws the motor directly on the line, and it may be used with either alternating- or direct-current motors. It consists of four single-pole contactors, mechanically interlocked, which are mounted on a base and enclosed in a small sheet-metal case convenient for mounting on a wall. A push-button station is provided for operating the contactors, which are so arranged that the motor will run only as long as the push-button remains depressed. For monorail-hoist or other intermittent duty, this starter may be used with motors of ratings up to five-horsepower on current of from 115 to 550 volts.

WHITNEY FREE-FLOATING FLEXIBLE COUPLING

An entirely redesigned and improved coupling of the Whitney free-floating flexible type is being placed on the market by the H. & O. Chain and Coupling Co., 83-87 Washington St., South Norwalk, Conn. This coupling permits a large amount of both parallel and angular misalignment of shafts and a large amount of endwise float. On standard couplings the maximum angular misalignment possible is 10 degrees, but couplings can be made to permit a misalignment of as much as 15 degrees. The end float varies from 1/8 inch on the 1/2-horsepower coupling to 3/4 inch on the 5,000 horsepower size. It is always as much as the end float necessary when using a direct-current motor of the size for which the coupling is intended. Six types of couplings are

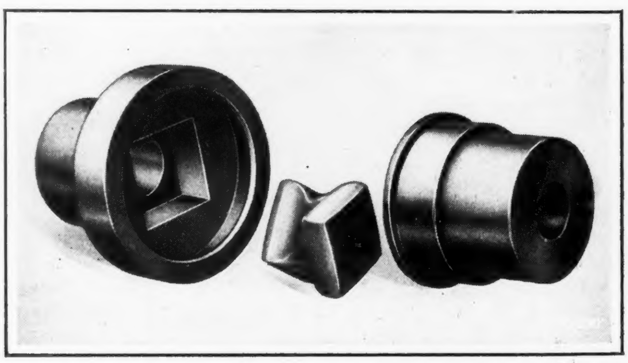


Fig. 1. Whitney Free-floating Flexible Coupling of Improved Design

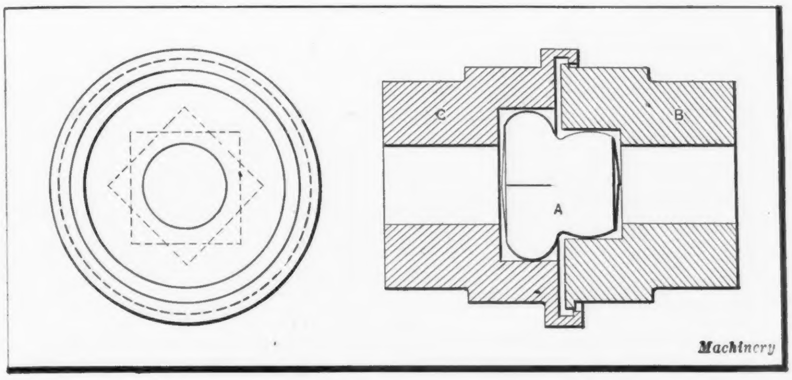


Fig. 2. Sectional View of an Assembled Whitney Flexible Coupling

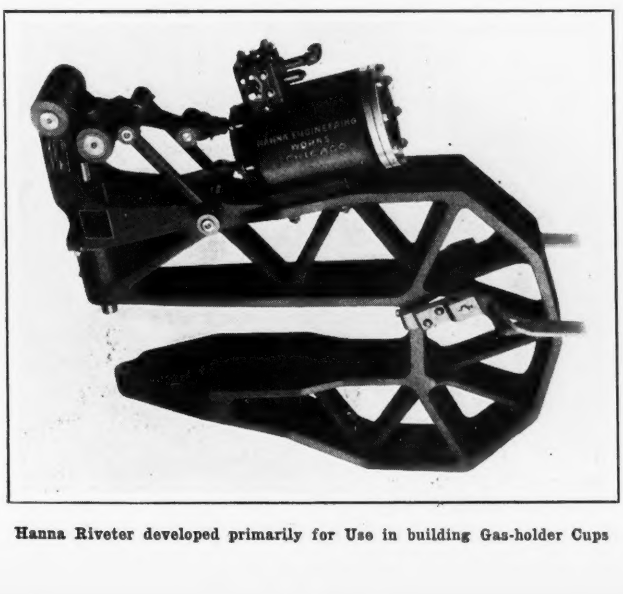
made in a large range of standard sizes between the 1/8- and 5000-horsepower capacities. Special sizes can be furnished to suit any installation.

The principles of the design can be understood from the disassembled view of a coupling shown in Fig. 1 and the sectional view of an assembled coupling illustrated in Fig. 2. Power is transmitted through a free-floating central link *A* which fits into sockets in the male hub *B* and in the female hub *C*. This link is free to rock in any direction and float laterally, and yet is of such design as to give a positive drive. There are eight rounded surfaces on the link that act as pivots in the hub sockets. The surfaces at one end of the link are at an angle of 45 degrees in relation to those at the other end.

HANNA RIVETER

A riveting machine developed especially for use in fabricating gas-holder cups has recently been placed on the market by the Hanna Engineering Works, 1763 Elston Ave., Chicago, Ill. These cups consist of a 7-inch channel iron and two plates, one of which is 42 inches wide and the other 15 inches wide. The plates are riveted to the flanges of the channel iron with their edges flush with the outside surface of the channel web so that the plates are in effect extensions of the channel flanges. The channel iron is bent on the edge to a long radius that is substantially the radius of the holder. The wide plate is riveted on the channel iron first and then the narrow plate. As the channel iron is 7 inches high and the narrow plate 15 inches wide, the dead stake of the riveter frame must be less than 7 inches deep at a point 15 inches back from the center of the rivet die. The cup section itself is cumbersome, and for this reason the riveter is used as a portable machine.

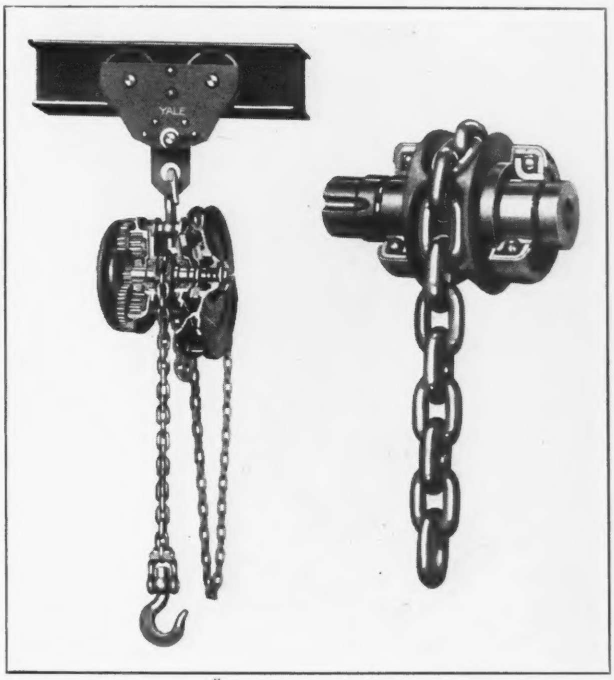
The machine has a reach of 42 inches and a gap of 12 inches. The cylinder is 10 inches in diameter and is capable of exerting 30 tons pressure on the dies with an air pressure of 100 pounds per square inch. The Hanna patented mechanism or motion that has been described in past articles dealing with riveting machines built by this company, is incorporated in this machine. This mechanism develops a predetermined pressure uniformly through the last half of the piston stroke or the last half-inch of the rivet die travel. The same machine can handle a gas-holder cup made up with an 8-inch channel-iron and an 18-inch narrow plate.



Hanna Riveter developed primarily for Use in building Gas-holder Cups

YALE CHAIN BLOCKS

Ball-bearing spur-geared chain blocks of improved design are being introduced to the trade by the Yale & Towne Mfg. Co., Stamford, Conn., in a range of sizes having rated capacities of from 1/4 to 20 tons of 2240 pounds. From the right-hand view in the accompanying illustration, it will be seen that the load sheave is carried in two large ball bearings. It is claimed that these bearings have much reduced the hand pull required to lift a given load, as they lessen friction at the bearing points of the load sheave shaft. The ball bearings are enclosed, and protected from dirt and grit by felt and steel washers which also serve to retain lubricant. All load-supporting parts between the two hooks are made of steel.



Yale Spur-geared Chain Blocks equipped with Ball Bearings for the Load Sheave Shaft

Lubricant is furnished to the different members by oil ducts that convey the oil to the ball bearings and then to the driving pinion shaft bearings. The driving pinion shaft is heat-treated and ground to size, and the load sheave shaft, which is hollow, is bronze-bushed to support the driving pinion shaft. All gears are enclosed in a malleable-iron cage. The steel load chain is die-formed, electrically welded, and heat-treated. Lengthening and shortening of the chain is possible in the field without welding, because of a detachable shackle and heat-treated oval pin which connects the hook to the last link in the chain.

OLIVER DRILL POINT THINNER

For accurately thinning the web of twist drills and correcting other errors occurring in the shape of drills, the Oliver Instrument Co., 1410 E. Maumee St., Adrian, Mich., has recently designed a drill point thinner which is intended

for use in conjunction with the Oliver drill pointer. The pointer is employed for automatically producing a point, both lips of which will cut the same amount and on which the strains of the drilling will be evenly distributed. The function of the point thinner is to correct such errors as are indicated by the dotted lines in Fig. 2.

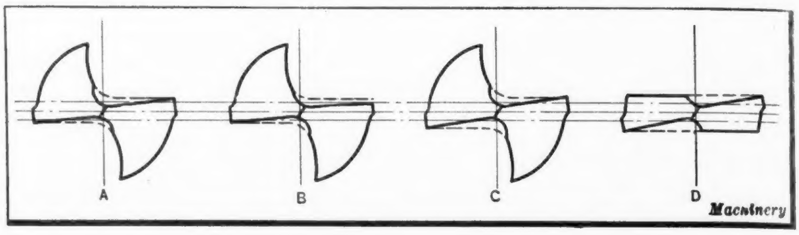


Fig. 2. Diagrams illustrating Drill Points before and after employing the Point Thinner

At *A* in this illustration, the dotted lines indicate a drill with a web that is out of center; at *B*, a drill with lips that are out of index; at *C*, a drill having an abnormally thick web; and at *D*, a drill of the flat twisted type having a web as thick as the land at the outside. The full lines in each case show the drill point after being ground by the point thinner, which grinds not only the web but the whole face of the cutting lip, preserving the original top rake and correcting any out-of-center condition of the web or out-of-index condition of the lip. It grinds the lip in such a way that the drill can be repeatedly resharpened without losing its shape, and there is no necessity of grinding away a part of the drill to overcome the effect of "lipping," as is frequently necessary when the operation is performed by hand.

Fig. 1. Oliver Drill Point Thinner for correcting Inaccuracies in Drills

As may be seen from Fig. 1, the point thinner consists of a grinding wheel mounted on a column and driven by a motor within the base. On the column is a knee that is moved vertically by rotating a handwheel. The knee supports a carriage which carries an arm equipped with an adjustable yoke that holds a sleeve into which the taper shank of the drill is inserted. Drill-holder trunnions rest in the yoke. The point of the drill is supported by a V-rest, and an adjustable side stop touches the point of the cutting edge at right angles to it.

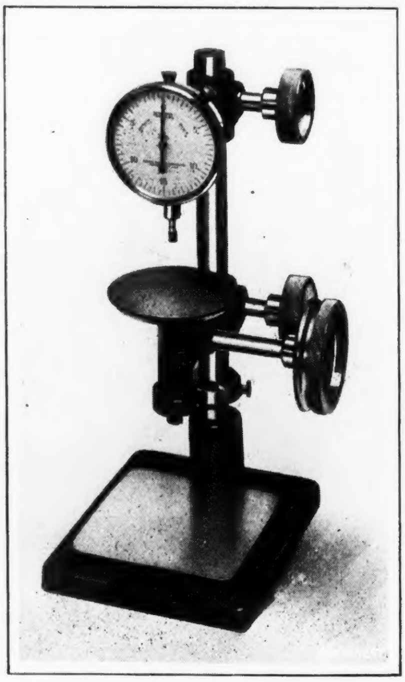
To set a drill for thinning, it is only necessary to insert the taper shank in the sleeve, lay the drill on the yoke by means of the trunnions, bring the lower V-rest to the proper height and finally adjust the side stop to touch the point. In operation, the carriage is moved forward by means of the lever and raised by turning the handwheel until the drill is sufficiently thinned on one side. Then the drill is indexed 180 degrees by turning over the drill-holder in the yoke for grinding the second lip in a similar manner. The grinding wheel is dressed to a slanting face by means of a diamond truing device attached to the machine.

CANNON "PUMP AND POUR" OILER

An oil-can equipped with two controls on the outside by means of which oil can be either pumped or poured into places where it is desired, is a recent development of the Cannon Oiler Co., Keithsburg, Ill. By means of the pump control, oil can be forced through the spout, even with the spout tilted upward, and delivered to the bearings of overhead shaft hangers, etc. The pour control enables large oil-cups to be quickly filled, the oil running out in a steady stream through a separate channel. This channel is large enough to allow the free passage of heavy oil, even in zero weather. Several sizes of the oiler are made.

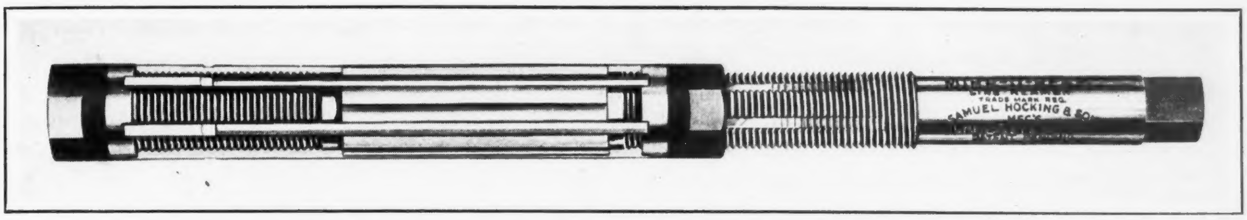
FEDERAL BENCH GAGE

A bench gage having a table which is raised to bring the work up to the spindle for measuring it, instead of lowering the spindle on the work, is manufactured by the Federal Products Corporation, 15 Elbow St., Providence, R. I. In case the user prefers to raise and lower the spindle rather than the table, this can be arranged for by simply manipulating a small button on top of the spindle and locking the table to the column. Several other features are claimed for this model 35 gage. For instance, there is a groove around the knurled handle employed to raise and lower the table, and a hole is drilled in this groove in which a cord or wire can be inserted and run over the groove to the floor to permit raising and lowering the table with the foot. In this way, both hands of the operator are free to handle the work, which is of considerable value when odd-shaped parts, which are hard to locate on the table, are being inspected.



Federal Bench Gage ordinarily used by raising the Work to the Spindle

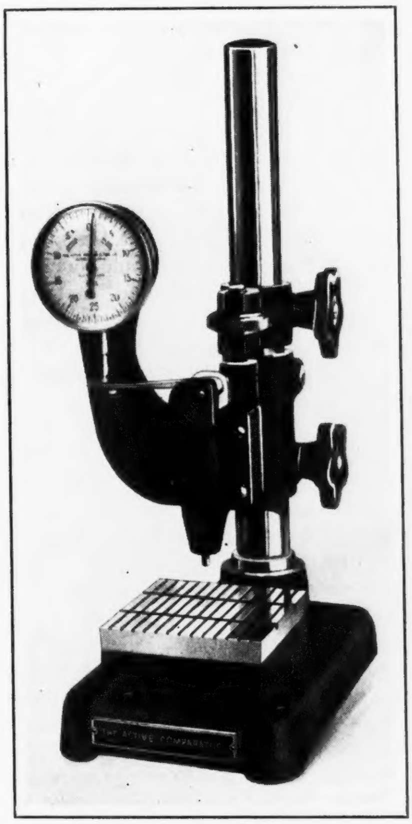
Another feature is that the table can be swung out of the way and the base of the machine used as a table for gaging large pieces. The gage is 2¾ inches in diameter, and has graduations spaced comparatively far apart so as to lessen the eye fatigue of the operator when the gage is used all day long. One complete turn of the hand measures only 0.030 inch, the space between the graduations representing a measurement of 0.0005 inch.



"Mirr-O-Ream" Expansion Line Reamer with Blades ground to a Double Relief

AMPLIFYING GAGE

For rapidly checking the dimensions of duplicate parts, the Active Machine & Tool Co., 1220 W. 6th St., Cleveland, Ohio, has recently developed the amplifying gage shown in the accompanying illustration. This device is furnished with a dial indicator connected to the contact point of the gage by means of a lever arm having a ratio of 10 to 1. As a result, the amplifying gage checks work to within 0.0001 inch. The indicator dial is of such size that a distance of 0.0001 inch on the work is represented by a movement of 3/16 inch of the indicator needle. This permits rapid readings and makes it easy to estimate fractions of 0.0001 inch with considerable accuracy.



Amplifying Gage made by the Active Machine & Tool Co.

The baseplate of the gage is equipped with a ground and lapped surface plate which supports the work as it is passed under the contact point. The dial indicator is carried on a bracket secured to a split collar which is clamped to the column. There is a second upper collar on the column which is used to accurately locate the bracket to which the indicator dial and the contact point are attached. In setting up the gage for a given job, a piece of work of known accuracy is laid on the surface plate and then the contact point is brought close to the work by sliding the two collars on the column. The upper collar is next clamped to the column and then the contact point of the gage is brought into actual contact with the work by sliding the lower collar on the column through the use of the screw adjustment on the upper collar. The lower collar is then also clamped to the column. Finally the indicator needle is coincided with the zero graduation on the dial.

Various auxiliary fixtures have been developed for handling a wide range of work such as parts that cannot be placed directly on the surface plate. Among these are fixtures that hold work on centers or in a V-block for checking the diameter and concentricity of cylindrical pieces. Another fixture is made for use in checking the longitudinal uniformity of the diameter of such pieces as wrist-pins. This consists of a surface plate having a shoulder against which the work is held as it is slid under the contact point. The gage has a capacity for work extending 6½ inches above the table.

"MIRR-O-REAM" EXPANSION REAMER

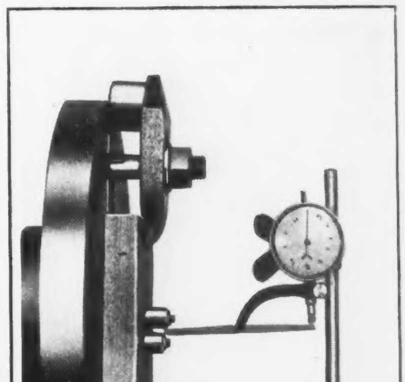
A "Mirr-O-Ream" line reamer of the expansion type is being manufactured by Samuel Hocking & Son, 35½-37 N. Prince St., Lancaster, Pa. The main difference between this reamer and past designs made by the company is that a pilot surface is ground on one end of the blades. Together these surfaces form a pilot that is expanded simultaneously with the blades, so that there is only one adjustment required, in changing the size of the reamer. In a reamer having blades 5 inches long, the pilot portion is 1⅜ inches long.

There are six tool steel blades fitted in grooves in the shank, the blades being of sufficient length to extend through an automobile piston. The ends of the blades are beveled and seated in beveled slots of steady rings that support and protect these ends, prevent breakage of the blades or nuts, and eliminate loose blades. They are also said to insure easy adjustment of the blades by keeping the nuts and the threaded portion of the shank in working condition. A double relief is ground on the blades with a view to preventing chatter, dragging, or chipping of the blades and insuring a mirror-like finish and a hole true to size.

BROWN & SHARPE TOOLMAKERS' BUTTONS

In using toolmakers' buttons for accurately locating holes in work prior to drilling and boring them in a lathe, it is often difficult to locate two closely spaced holes, because of the buttons being so near together that the contact point of a test indicator cannot be passed between them when the work is revolved. To overcome this difficulty, the Brown & Sharpe Mfg. Co., Providence, R. I., is manufacturing sets of four buttons each, one button of each set being ⅛ inch longer than the others.

When two holes are to be produced close together, the long button is used for the hole that is to be drilled and bored first, and because of being higher than the adjacent button, the indicator can be brought in contact with the long button as the work is revolved. Three sets are manufactured, with buttons 0.300, 0.400, and 0.500 inch in diameter, respectively. Three buttons of each set are ½ inch long, and the fourth, ⅝ inch. The buttons are mounted on a steel base which is thick enough to protect the end of the screws that hold them to the base. The ends of the buttons are ground square with the sides.

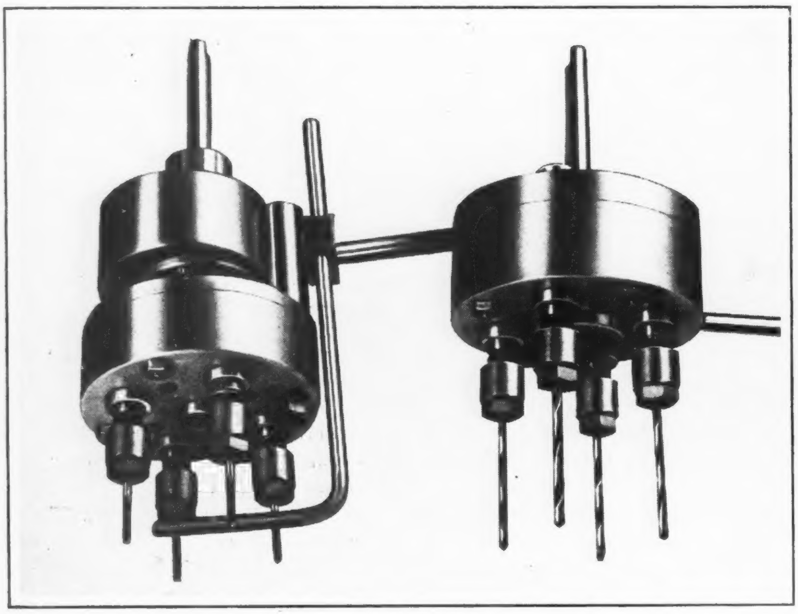


Using Brown & Sharpe Long and Short Buttons close together

ERRINGTON MULTIPLE TAPPING AND DRILLING HEADS

Patents have recently been granted to the Errington Mechanical Laboratory, 11 John St., New York City, to cover a compact sensitive multiple-spindle tapping head that the concern is now placing on the market. This device is shown at the left in the accompanying illustration. It consists essentially of a multiple number of tap-holders applied to the Errington reverse gear. While the spindles of drilling machines generally run clockwise, it is sometimes preferable to run the spindles of tapping devices counter-clockwise for right-hand tapping, in order that the gears of the tapping device may be larger and stronger. This is the principle upon which the tapping head described in this article is based.

Floating universal-joint tap-holders are used so as to make it possible to tap holes simultaneously in parts having distorted surfaces, without breaking the taps. The sensitiveness of the device is largely due to the fact that the positions of the holders are not adjustable. When it is desired to use a head for tapping holes of more than one series of center distances, additional spindle bearings can be provided, or even additional spindles that are not equipped



Errington Multiple-spindle Tapping and Drilling Heads

with taps during an operation in which the other series of spindles is used. The multiple drilling head shown at the right is designed on the same principle as the tapping head. Multiple hollow-milling heads and multiple die-holders are also produced by this concern.

FAFNIR DUST SEAL FOR BALL BEARINGS

Ball-bearing equipped hanger boxes and pillow blocks with an extra dust seal, which are especially designed for installation in grinding and woodworking departments or other places where there is a large amount of dust or dirt, are being manufactured by the Fafnir Bearing Co., New Britain, Conn. The seal is merely an extension on the self-locking collar which encloses the end of the box and fits over the corners so as to keep the dirt from working down into the ball bearing. The corners are cut down and provided with a ridge to prevent dirt from entering, the seal fitting snugly around the corners. Since the seal revolves with the collar and the shaft, it tends to throw the dirt outward by centrifugal force, and this is said to result in an absolutely dustproof enclosure. This dust seal is necessary only under exceptionally dirty conditions, pressed-steel dust caps usually proving satisfactory.

MANAGING A LARGE BUSINESS

In an article in *System* entitled "My Test of Management," Charles Piez, president of the Link-Belt Co., lays down some rules relating to successful management of large enterprises. In this article Mr. Piez states that the man who carries the burden of directing the activities of a large manufacturing or business organization must not load himself up with detail work. He must delegate it all to subordinates and reserve for himself only the making of decisions that affect the policies of the enterprise, and that are required to take care of exceptions, leaving all the routine business to those especially employed to handle that work.

"As soon as a task crops up that must be repeated again and again," says Mr. Piez, "it is time to pass it on to a man who can specialize on it. That is the test by which I have found it best to delegate work. Does the task present itself often enough so that another man should do it as part of his regular work?" Mr. Piez also states that the men in the Link-Belt Co.'s employ who are on the up grade are taught that while their earlier jobs may consist of the constant repetition of certain duties which they attend to personally, when they are placed in charge of a department or a plant, they are expected to direct others how to do the work, and then to see that it is done that way. They are not to narrow down their own field of vision with a great deal of detail work. "No man can steer," says Mr. Piez, "who cannot see the whole horizon.

"My experience has indicated that the larger the organization grows, the more the duties of the chief executive partake of a teaching or coaching character, combined with that of charting a course through the broad field of business. All of these duties do not involve any detail work on the part of the executive, but they do involve a great deal of thought, of study, or contemplation, and—if I may use the word in a non-trivial sense—of dreaming.

"Modern management is built up on what may be termed the exception plan. The head of each department, while supervising routine operations, has referred to him for decision only such matters as are out of the ordinary—everything, in fact, that the man doing the routine work cannot himself decide. The department head decides as many of these questions as he feels competent to do, and passes the more difficult decisions on to his superior. The executive must not immerse himself in routine matters, but must hold himself free to take care of the exceptions. He is, in effect, an emergency man. His usefulness would be greatly impaired if he immersed himself in detail work."

* * *

JOHN FRITZ MEDAL IS AWARDED TO JOHN F. STEVENS

The twenty-first award of the John Fritz gold medal, the highest honor awarded for great achievement by the engineering profession in this country, has been made to John F. Stevens of New York City, for "great achievements as a civil engineer, particularly in planning and organizing for the construction of the Panama Canal; as a builder of railroads; and as administrator of the Chinese Eastern Railway." The medal is awarded annually for notable scientific industrial achievements by a board representing the American Societies of Civil, Mining and Metallurgical, Mechanical, and Electrical Engineers. Among the men who have formerly been awarded this medal are Lord Kelvin, George Westinghouse, Alexander Graham Bell, Thomas A. Edison, Alfred Noble, John E. Sweet, Elihu Thomson, George M. Goethals, Orville Wright, Sir Robert Hadfield, Marconi, and Ambrose Swasey.

DIES FOR DRAWING ALUMINUM SHELLS

By GEORGE R. CASTER

Among the interesting press operations involved in the manufacture of aluminum cooking utensils is the drawing of deep shells. It has been the writer's experience that this can best be done by using dies of the type shown in the accompanying illustrations. These particular dies are used in drawing coffee percolators from 18-gage sheet aluminum blanks 12½ inches in diameter.

The first drawing operation is performed on the die shown in Fig. 1, which forms a shell 7¾ inches in diameter by 3½ inches deep. It will be noted that the outside diameter of the die body *A* is the same as the blank diameter, or 12½ inches. The punch *B*, blank-holder *C*, and knock-out pad *D* are of the usual design employed in forming shells in a toggle drawing press.

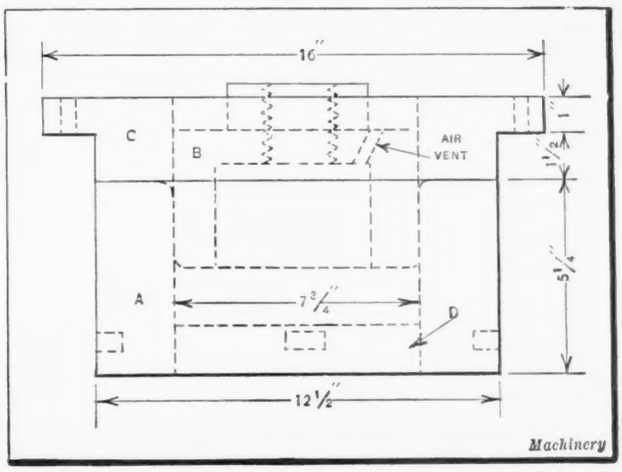


Fig. 1. Die for First Drawing Operation on Aluminum Shell

For the second drawing operation, the shell is turned upside down and placed over the die *E*, Fig. 2. The different members of this die are made of cast iron, the blank-holder and dies of the second and third operations being made from the same pattern. Both of these members are machined to the same outside diameter, which must be a free or loose fit for the shell produced in the first operation. After the shell is placed over die *E*, the punch *G* descends and draws the shell up over the outside of the die and down on the inside, turning the shell inside out. The shell produced in this operation is 6¼ inches in diameter by 5¾ inches deep.

The third operation is performed in the same manner as the second, the shell being again turned inside out by the use of the die shown in Fig. 3. This die is constructed the same as the one used for the second operation except that it is dimensioned to produce a finished shell 4⅞ inches in diameter by 7⅝ inches deep. It has been found that the best results are obtained when the clearance between the punch and the die is 1¼ times the thickness of the metal to be drawn. The radius to which the corners of the dies and blank-holders are finished must also be made to suit the metal being drawn. Decreasing the radius will increase the length of the drawn shell, but with this increase in length there is more danger of shells being spoiled by the breaking away of the metal. In the case of the die shown in Fig. 3, both the inside and outside edges are rounded to a radius of 3/16 inch.

When drawing work of the kind described, the blanks are well greased before being sent to the first drawing die. Trademarked blanks should be put in the first drawing die with the trademarked side down so that the marking will be on the outside of the finished shell.

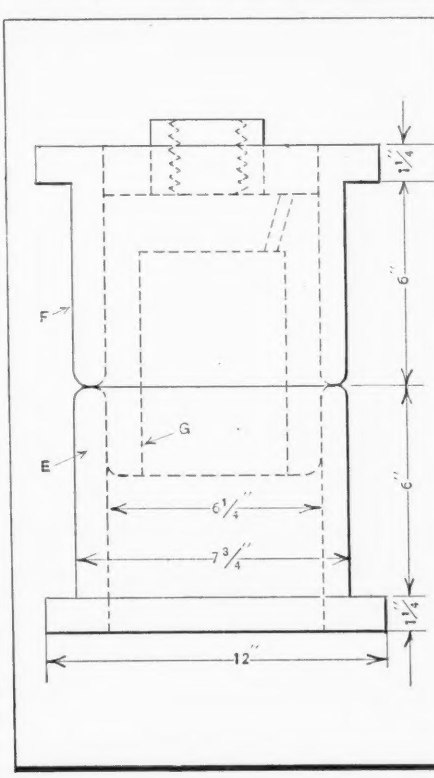


Fig. 2. Second-operation Drawing Die

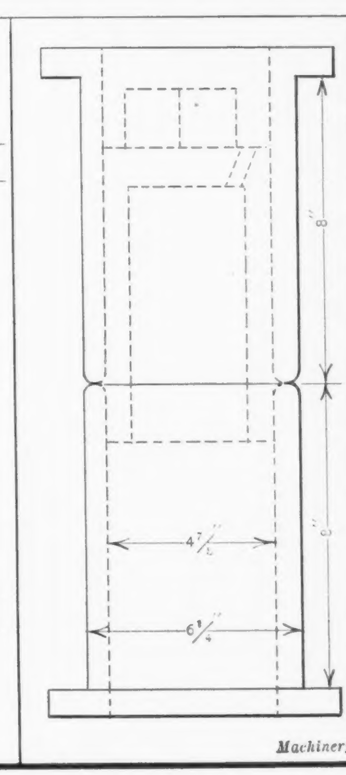


Fig. 3. Third-operation Die

* * *

MACHINE TOOLS IN ITALY

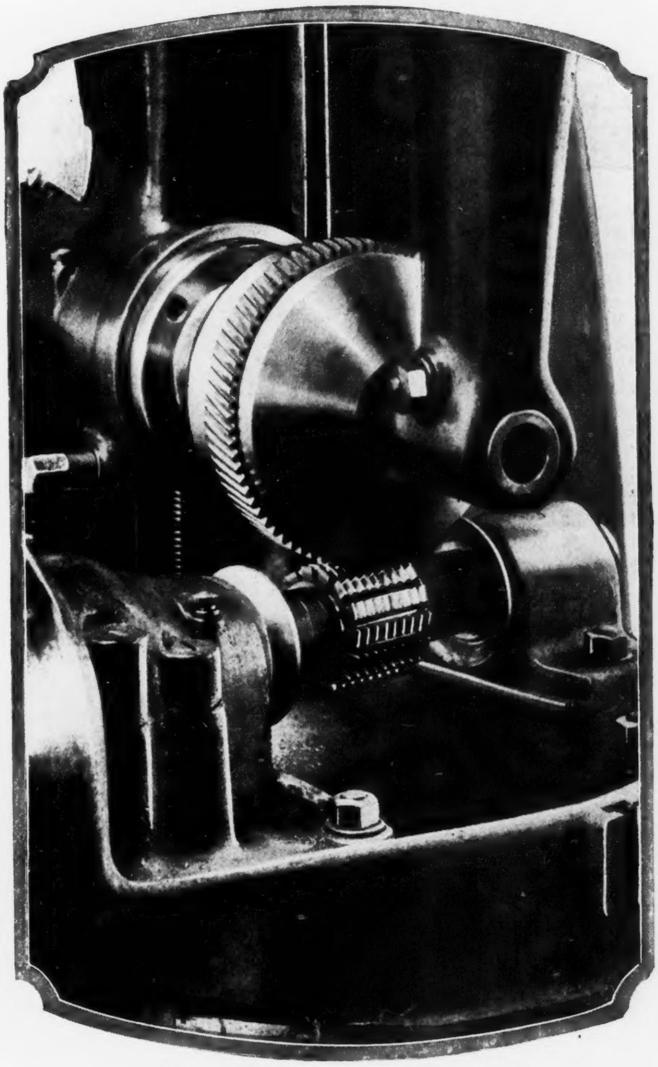
In referring to the possibilities for the sale of American machine tools in Italy, a prominent Italian machine tool dealer writes us that the only American machines that it has been possible to sell during recent years have been those of a special type that would be purchased only by large plants where work is produced in considerable quantities. In this class of machine tools Europe, as yet, cannot compete with America. As far as standard machine tools are concerned, the difference between American and European prices is too great, and when normal exchange conditions are once more established, it will be necessary for the dealers in American machine tools to begin all over again the work they have done in introducing in the Italian market the higher type of American standard machine tools.

"It must also be remembered," says this dealer, "that both England and Germany have improved the quality of their machine tools so that the products of both nations now compete with American machines on a more even basis. In less high-grade tools, English and German manufacturers lose out to Italian makers, who produce this class of machinery at better prices, but the larger portion of the sales in good standard machines goes to English and German machine tool builders. As far as Germany is concerned, manufacturers find themselves now in a more favored position, because since January 11, machine tools from Germany are subject to the same import duty as machines from England or America.

Proceeding further, our correspondent writes, "I think it necessary also to draw your attention to the fact that the limitation of Italian immigrants into the United States and the prohibition law, which deprives Italy of one of her important former exports to the United States, have caused rather heavy losses to our country, and this has not added to the general spirit of friendliness to the United States."

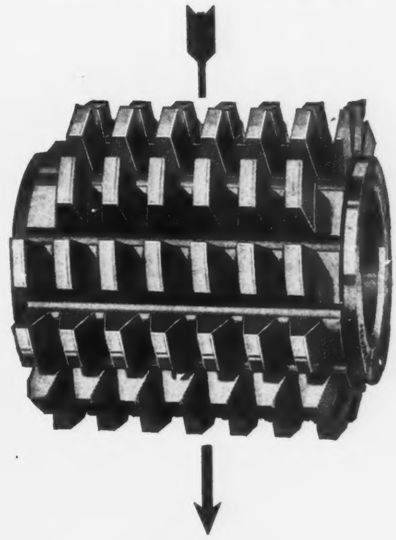
In 1923 and 1924 there was a marked renewal in the industrial life of Italy, due especially to the firm hand with which Italy is now being governed. It is believed by industrial leaders in Italy that Mussolini will be strong enough to overcome the opposition, and that his administration will mark a real advance in industry.

BROWN & SHARPE



Hobbing a helical timing gear

Ground Hobs



Why We Grind the Form

Grinding, after hardening, corrects the hob for all slight distortions. It gives each tooth of the hob a form so perfect that in addition to cutting accurately, it takes its exact share of the cut. This permits faster feeds and speeds to be used, and also reduces the power consumed.

For high production with accuracy, investigate Brown & Sharpe Ground Hobs.

BS

BROWN & SHARPE MFG. CO.
Providence, R. I., U. S. A.

SHARPE

Gear Makers who are using Brown & Sharpe Ground Hobs are enthusiastic over the fine results they give. Try them on your work—send for Catalog No. 29 today—it lists all our gear cutters.

PERSONALS

J. W. Hildebrand, formerly connected with the Jones Foundry & Equipment Co. of Chicago, Ill., has recently joined the sales force of Foote Bros. Gear & Machine Co. as sales engineer.

B. J. Flanagan, formerly treasurer of Herberts Machinery & Supply Co., San Francisco, Cal., has established a business of his own, specializing in the sale of metal-working machinery, at 321 Clay St., Oakland, Cal.

E. P. Burrell, director of engineering of the Warner & Swasey Co., Cleveland, Ohio, and William J. Burger, works manager, were presented with gold watches at the last annual meeting of the company in recognition of twenty-five years of continuous service.

J. L. Osgood, machine tool dealer of Buffalo, N. Y., and manufacturer of the Osgood file handles and file grips, has recently sailed for a trip around the world via the Panama Canal. He will visit Hawaii, Japan, India, Egypt and the principal European countries, and will return about July 1.

Percy M. Brotherhood, formerly first vice-president of Manning, Maxwell & Moore, Inc., after thirty years' service, has resigned his connection with that firm, and after a short rest will consider plans for the future.

Mr. Brotherhood's address will be the Engineers' Club, 30 W. 40th St., New York City.

Arthur T. Clarage has been elected president of the Columbia Tool Steel Co., Chicago Heights, Ill., succeeding A. R. Waters. Mr. Clarage is a son of the late E. T. Clarage, who was founder and first vice-president of the company. He has held many positions with the company, and has been general manager and director since 1904.

A. C. Cook, general sales manager of the Warner & Swasey Co., Cleveland, Ohio, has been promoted to the position of vice-president, and has been made a member of the board of directors. Mr. Cook entered the employ of the company twenty-four years ago. He has served as district manager of the New York territory and has represented the company abroad on three extended trips to Europe. For the last ten years he has held the position of general sales manager.

David B. Rushmore, one of the consulting engineers of the General Electric Co., Schenectady, N. Y., has resigned his position, following orders from his physician to take a long rest. Mr. Rushmore will make his headquarters in New York City at the University Club. He has been connected with the company for twenty-five years, seventeen of which he was engineer of the power and mining department, and since 1922 he has served as consulting engineer.

Lyman W. Close, for several years chief engineer of the Bock Bearing Co., Toledo, Ohio, and David R. Feemster, who for about eleven years has been connected with the same company, handling special work in connection with the sheet-metal department where the roll retainers for the Bock bearings are made, have left the Bock Bearing Co. and engaged in business for themselves under the name of the Lyda Machine Products Co. Their plant is located in the Toledo Factories Building, Toledo, Ohio, where they have installed complete equipment for the manufacture of dies and the production of all kinds of sheet-metal stampings.

G. H. Feltes, treasurer of the United States Electrical Tool Co. of Cincinnati, Ohio, which he helped organize in 1905, has sold his interest to J. A. Smith, his associate, and plans to take a rest until next fall.

The United States Electrical Tool Co. has been markedly successful with their line of electrically driven drills and grinders, having started in a small room in 1905, and built up the business to a point where the present large factory is necessary to handle the product.

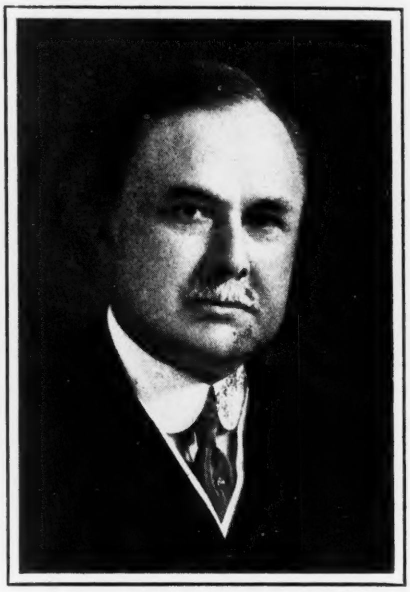
Mr. Feltes was secretary and treasurer from 1905 to 1920, when he was appointed treasurer and sales manager, the position which he has just resigned.

C. L. Goodrich has recently returned to the Pratt & Whitney Co., of Hartford, Conn., as assistant to the general manager. Mr. Goodrich was formerly connected with the Pratt & Whitney Co. for many years, during which time he was actively associated with the company's gage business. He was also in charge of the manufacture of much of the large arsenal equipment which the company has installed throughout the world. Mr. Goodrich left the Pratt & Whitney Co. to become acting general manager of the Bement Works in Philadelphia. He has been recalled to the company to resume his work on gages, and also to take charge of the building of special machines and tool equipments.

OBITUARIES

ADOLPH E. BRION

Adolph E. Brion, chairman of the board of directors and former president of Peter A. Frasse & Co., Inc., New York City, died January 25. Mr. Brion was well known in steel circles, having been associated for almost half a century with Peter A. Frasse & Co., Inc. In 1878 he went to the company in a minor capacity, but his ability was soon recognized and won him frequent advancements until he became an important factor in the affairs of the company. In 1904 he was elected president, and in 1916 he founded the Frasse Steel Works at Hartford, Conn. In September, 1924, he resigned as president because of poor health and was elected chairman of the board of directors. Mr. Brion was born March 19, 1863 in Brooklyn, N. Y., where he resided for many years. At the time of his death his home was in Forest Hills Gardens, L. I. He was a member of the American Iron and Steel Institute and the Society of Automotive Engineers. His wife, a daughter, and a son, who succeeded him as president of Peter A. Frasse & Co., Inc., survive him.



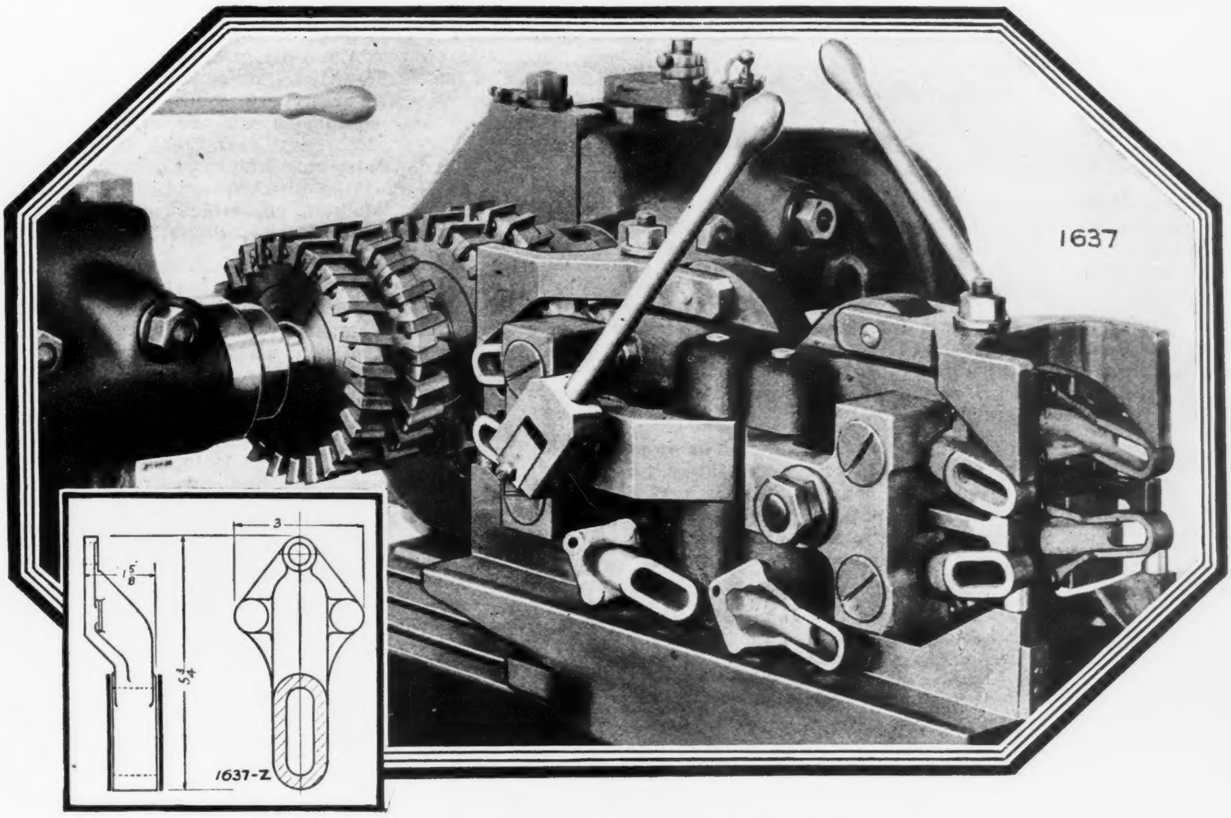
Dexter W. Parker, president of the Charles Parker Co., Meriden, Conn., died at his home on February 8. Mr. Parker, who was seventy-five years of age, was the last of the children of Charles Parker, founder of the business. He was a graduate of West Point, class of 1870, commissioned with the rank of second lieutenant. After eight years of service in the army, he resigned his commission and returned to Meriden as his father's partner. In 1902 he became president of the organization, and although of late years he had not been active, owing to ill health, he retained his office until his death.

Harry A. Shier, Pittsburg district representative of the tool steel department of Henry Disston & Sons, Inc., Philadelphia, Pa., died at his home in Crafton, Pa., January 24. Mr. Shier had been connected with the company for a year, and previous to that was associated with the Onondaga Steel Co. of Syracuse, N. Y., and the Bethlehem Steel Co. of Bethlehem, Pa.

William F. Hillebrand, chief of the chemistry division of the Bureau of Standards, died February 7, following a short illness, at the age of seventy-one. Dr. Hillebrand had been chief of the chemistry division for the last seventeen years and continued in active service up to the beginning of the illness that led to his death.

EXAMINATIONS FOR JUNIOR PATENT EXAMINERS

An examination for junior patent examiners will be held throughout the United States on April 22 and 23 to fill vacancies in the Patent Office, at an entrance salary of $1860 a year. Advancement in pay may be made without change in assignment up to $2400 a year. The examination will include one of the following optional subjects: Civil engineering, electrical engineering, mechanical engineering, chemical engineering, or electro chemistry. Full information and application blanks may be obtained from the United States Civil Service Commission, Washington, D. C., or from the secretary of the Board of U. S. Civil Service Examiners at the post office or custom house in any city.



Grouping Work for Maximum Production

Keen competition demands efficient machine tools. That is why a large automobile manufacturer installed 30 equipments supplied by our Engineering Service Department. In this case a 24″ Duplex Automatic Cincinnati Miller is shown milling the bosses on fan brackets. As the drawing indicates, an interesting chucking problem is presented, inasmuch as the finished bosses must be parallel with the short bearing surface on the cylinder.

Four pieces are milled simultaneously, being grouped in pairs in such a way that only four side mills are required. Two cam clamps secure each group, the side clamps squaring the pieces against the finished triangular pad and the top clamps binding them together. A production of 200 pieces per hour is secured.

THE CINCINNATI MILLING MACHINE COMPANY
CINCINNATI, OHIO

USE OUR "SERVICE THAT SAVES"

Send today for our new book "Service that Saves" showing over 50 successful installations equipped with special fixtures, speeding production, cutting costs, and increasing profits. Fill in and return this coupon today.

NAME ....

NAME OF COMPANY ....

POSITION ....

ADDRESS ....

CINCINNATI MILLERS

TRADE NOTES

SWIND MACHINERY Co., Philadelphia, Pa., announces the opening of a new Baltimore office at 902 Standard Oil Building, Franklin St. and St. Paul Place.

COLONIAL STEEL Co., Pittsburg, Pa., has established a Philadelphia branch at 522 Drexel Bldg., Philadelphia. The district sales manager is John A. Succop.

HUSKY WRENCH Co., 928 Sixteenth Ave., Milwaukee, Wis., has increased its capital stock from $50,000 to $90,000, and is adding a new line of large industrial socket wrenches to its standard line of interchangeable-socket wrenches for automotive maintenance work.

C. U. WILLIAMS Co., Bloomington, Ill., is erecting a new building covering 30,000 square feet of floor space, for the manufacture of the Williams "Oil-O-Matic" burners. The construction work is carried out by the Austin Co., engineers and builders, Cleveland, Ohio.

NORTHERN ENGINEERING WORKS, Detroit, Mich., at their recent annual meeting, elected the following officers for 1925: President and treasurer, Henry W. Standart; vice-president, William V. Moore; vice-president and consulting engineer, Edward S. Reid; secretary, Louis H. Olfs; chief engineer, W. Robertson; and sales manager, S. E. Schneider.

CANTILEVER WRENCH CORPORATION, 354 Mulberry St., Newark, N. J., has taken over the assets and liabilities of the CANTILEVER WRENCH Co., INC., manufacturer of the Cantilever reversible and ratchet chain pipe wrenches. The officers of the new company are as follows: President and treasurer, W. E. Cooke; vice-president and general manager, A. B. Cozzens; and secretary, F. J. Carnelli.

JOSEPH DIXON CRUCIBLE Co., Jersey City, N. J., has recently moved its Boston office from 49 Federal St., to the new Chamber of Commerce Building (Room 320), at 80 Federal St. The staff of the Boston office consists of H. A. Nealley district representative in charge of lubricant and paint sales; Guy W. Hart and William E. Haggerty, pencil sales; Charles A. Shaw and R. H. Brinkerhoff, crucible sales; and J. W. Loftus, lubricant and paint sales.

MARSHALL & HUSCHART MACHINERY Co., 17 S. Jefferson St., Chicago, Ill., will hold a machine tool exhibit in the company's showrooms March 2 to 7, inclusive. Thirty different machine tools will be exhibited under power, representing the latest developments in machine tool designing practice. Work has been obtained from various shops in the Chicago district on which operations will be performed so as to show the machines in actual production.

CHICAGO PNEUMATIC TOOL Co., 6 E. 44th St., New York City, has entered into an agreement whereby it will become exclusive distributor in the United States of the Pedwyn balancer for suspending, lifting, and balancing electric and pneumatic portable tools. A stock of these balancers will be carried in the various branch and service stations. The company also announces that it has opened a branch office in Mexico at la San Juan de Letran 15, Mexico City, D. F.

E. L. ESSLEY MACHINERY Co., 551 W. Washington Blvd., Chicago, Ill., has recently completed arrangements with the Foster Machine Co., of Elkhart, Ind., to represent that company exclusively in the Chicago territory for the sale of Foster screw machines and Foster-Barker wrenchless chucks. The company has also completed negotiations with the Nazel Engineering & Machine Works of Philadelphia, Pa., for the exclusive sale of Nazel air hammers throughout the Chicago territory.

OBERLIN MACHINERY Co., Oberlin, Ohio, has taken over the business of the Parker Arbor Co., of Ann Arbor, Mich., who have been making a three-jawed, tooth-sleeved drill chuck. The business and equipment will be moved to Oberlin. Gorham C. Parker, for many years with the Jacobs Mfg. Co., of Hartford, Conn., and later president of the Parker Arbor Co., has joined the Oberlin organization as sales director, and B. L. Morgan, superintendent of the Parker Arbor Co., has been retained as superintendent.

GISHOLT MACHINE Co., 1300 E. Washington Ave., Madison, Wis., manufacturer of turret lathes, boring mills, and other machine tools, recently gave a banquet to all employes who have been with the company twenty years or more. Fifty-four men were invited from all departments of the plant. There were eight men who had served 30 to 33 years; nineteen, 25 to 29 years; and twenty-seven, 20 to 24 years. At the same time service pins were issued to thirty-nine men who had been with the company from 15 to 19 years each, to thirty-five men who had served 10 to 14 years, and to one hundred and thirteen men who had served from 5 to 9 years.

SIMONDS SAW & STEEL Co., Fitchburg, Mass., recently presented service pins to all its employes who have served the company for five years or more. For five years' service, the pin carries one gold star; for ten years, two stars; for fifteen years, three stars; for twenty years, an emerald; for thirty years, a ruby; for forty years, a diamond; and for fifty years, two diamonds. Two employes have been connected with the company for fifty or more years, nine received pins for forty years' service, twenty-four for thirty years' service, 141 for twenty years' service, 146 for fifteen years' service, 184 for ten years' service, and 494 for five years' service.

SIMONDS SAW & STEEL Co., Fitchburg, Mass., announces that Alvan T. Simonds, president of the company, has offered two prizes, one of $1000 and one of $500, for the best two essays on the following subject: "Your Prosperity and Mine." The contest is open to all residents of the United States and Canada, and will especially appeal to business executives and students of business and commerce. These prizes are offered to encourage the study of economics, and the essays must reach the Contest Editor, Simonds Saw and Steel Co., 470 Main St., Fitchburg, Mass., on or before December 31, 1925. Complete details relating to the contest may be obtained by addressing the company.

CONSOLIDATED MACHINE TOOL CORPORATION OF AMERICA, with general offices at Rochester, N. Y., announces the removal of the Newton Machine Tool Works from Philadelphia, Pa., to the works at Rochester. This follows closely upon the removal of the Colburn Machine Tool Works from Cleveland, Ohio, to Rochester, which has been accomplished without material interruption to production and with great economies in operation. The corporation consists of five divisions, three of which, Betts, Colburn, and Newton, are now located at Rochester, N. Y.; Hilles & Jones Works at Wilmington, Del.; and the Modern Tool Works at Erie, Pa. Encouraging reports as to business conditions have been given out by the corporation. The Hilles & Jones Works have added materially to their working force on account of an increased amount of business. The Modern Tool Works have more business in small tools than they have had in any similar period since the consolidation. The Rochester Works are enlarging their facilities and adding to their shop forces.

COMING EVENTS

MAY 5-7—Joint convention of the Southern Supply and Machinery Dealers' Association and the American Supply and Machinery Manufacturers' Association in Atlanta, Ga.; headquarters, Atlanta-Biltmore Hotel. Secretary-treasurer, F. D. Mitchell, 1819 Broadway, New York City.

MAY 6-8—National convention of the Society of Industrial Engineers in Cleveland, Ohio; headquarters, Hotel Winton. Executive secretary, George C. Dent, 608 S. Dearborn St., Chicago, Ill.

MAY 7-9—Ninth annual meeting of the American Gear Manufacturers' Association at the William Penn Hotel, Pittsburg, Pa. T. W. Owen, secretary, 2443 Prospect Ave., Cleveland, Ohio.

MAY 11-23—(instead of January 19-31) Southern Exposition to be held at Grand Central Palace, New York City. Further information may be obtained from William G. Sirrine, Greenville, S. C., or the Merchants' Association of New York, 233 Broadway, New York.

MAY 18-21—Spring meeting of the American Society of Mechanical Engineers in Milwaukee, Wis. Secretary, Calvin W. Rice, 29 W. 39th St., New York City.

JUNE 16-19—Summer meeting of the Society of Automotive Engineers at Greenbrier Hotel, White Sulphur Springs, W. Va. Secretary, Coker F. Clarkson, 29 W. 39th St., New York City.

JUNE 22-26—Annual meeting of the American Society for Testing Materials at Chalfonte-Haddon Hall, Atlantic City, N. J. Secretary-Treasurer, C. L. Warwick, Engineers' Club Building, 1315 Spruce St., Philadelphia, Pa.

JUNE 24-26—Twelfth National Foreign Trade Convention in Seattle, Wash. Secretary of the National Foreign Trade Council, O. K. Davis, India House, Hanover Square, New York City.

SEPTEMBER 8-11—Machine Tool Exhibition in the Mason Laboratory, Sheffield Scientific School, Yale University, New Haven, Conn. H. R. Westcott, chairman, 400 Temple St., New Haven, Conn.

SEPTEMBER 14-18—Annual convention of the American Society for Steel Treating, and Seventh National Steel Exposition, to be held at the Public Auditorium, Cleveland, Ohio. Secretary, W. H. Eisenman, 4600 Prospect Ave., Cleveland, Ohio.

NEW BOOKS AND PAMPHLETS

CRACK DEVELOPMENT IN GLASS UNDER ELECTRICAL STRESS. By Earle E. Schumacher. 6 pages, 6 by 9 inches. Published by the Western Electric Co., Inc., 195 Broadway, New York City.

MAGNETIC MEASUREMENTS ON MATERIALS OF HIGH INITIAL PERMEABILITY. By P. P. Cioffi. 8 pages, 6 by 9 inches. Published by the Western Electric Co., Inc., 195 Broadway, New York City.

THAWING FROZEN WATER PIPES WITH ELECTRIC CURRENT. By D. D. Ewing and C. F. Bowman. 16 pages, 6 by 9 inches. Published by Purdue University, Lafayette, Ind., as Bulletin No. 7 of the Engineering Extension Service.

EFFECT OF HOT-ROLLING CONDITIONS ON THE PHYSICAL PROPERTIES OF A CARBON STEEL. By John R. Freeman, Jr., and A. T. Derry. 20 pages, 7 by 10 inches. Published by the Department of Commerce, Washington, D. C., as Technologic Paper No. 267 of the Bureau of Standards.

THE MECHANISM FOR THE GRAPHITIZATION OF WHITE CAST IRON AND ITS APPLICATION TO THE MALLEABLIZATION PROCESS. By Anson Hayes and W. J. Diederichs. 45 pages, 6 by 9 inches. Published by the Iowa State College of Agriculture and Mechanic Arts, Ames, Iowa, as Bulletin No. 71 of the Engineering Experiment Station.

THE SLIDE-RULE. By H. T. Erickson. 32 pages, 6 by 9 inches. Published by the Bruce Publishing Co., 354 Milwaukee St., Milwaukee, Wis. Price (paper bound), 32 cents.

This little book is a beginners' description of the slide-rule and its uses. Particular stress is laid on the essential processes, multiplication and division, and the aim has been to eliminate guesswork in the location of the decimal point. The material is based on the author's experience in teaching slide-rule fundamentals to drafting students for many years.

MECHANICAL WORLD ELECTRICAL POCKET BOOK FOR 1925. 326 pages, 4 by 6 inches. Published by Emmott & Co., Ltd., 65 King St., Manchester, England. Price, 1/9d.

The latest edition of this well-known electrical pocket book has several new features. One of these is the addition of a section dealing with primary cells. A lengthy section has also been introduced describing up-to-date methods of testing generators, motors, and transformers, while still another section deals with various electrical supply systems. A section on X-rays has been included, as well as a section dealing with electric battery vehicles. Other parts of the book have been revised, and new illustrations have been added where necessary.

THE PRINCIPLES OF MACHINE DESIGN. By Robert F. McKay. 408 pages, 5½ by 8½ inches. Published by Longmans, Green & Co., 55 Fifth Ave., New York City. Price, $6.

This book on machine design discusses the design of component parts and connections that are more or less common to all types of machinery. It has been the aim to develop the basic principles on which machine design rests, and by a careful analysis and classification to indicate to the young engineer the possibilities and limitations of the devices illustrated, at the same time giving to the experienced engineer data in a convenient form for reference. The book is divided broadly into three sections: The first section deals with general considerations affecting machine design, the testing and the properties of materials of construction, and the utilization of the data of strength tests. The second section describes and classifies various methods of making permanent or temporary connections, such as rivets, bolts, pipes, joints, shafts, keys, and couplings. The third section deals with the problems arising in arranging for the support of moving parts, and covers the subjects of lubrication and bearings. The last chapter, which discusses alignment charts, may be regarded as an appendix.

NEW CATALOGUES AND CIRCULARS

HOBS. Gould & Eberhardt, Chancellor Ave., Newark, N. J. Bulletin 132, describing the G & E system of automatically hobbing worms with a hob having a broaching action.

THERMOSTATIC METAL. H. A. Wilson Co., 97 Chestnut St., Newark, N. J. Pamphlet descriptive of the characteristics and field of application of "Wilco" thermostatic metal.

THRUST BEARINGS. Kingsbury Machine Works, Philadelphia, Pa. Bulletin G, giving dimensions, capacities, and mountings of Kingsbury thrust bearings for dredge and propeller service.

GEARS. Foote Bros. Gear & Machine Co., 232-242 N. Curtis St., Chicago, Ill. Leaflet descriptive of Foote IXL ground-tooth spur gears, which are accurate to two ten-thousandths of an inch.

ELECTRIC RESISTORS. Monitor Controller Co., 500 E. Lombard St., Baltimore, Md. Circular entitled "A New Principle of Ventilation," descriptive of the Monitor "edge-wound" resistor.

LAPPING MACHINES. Moline Tool Co., Moline, Ill. Circular descriptive of the Moline No. 5 lapping machine, a six-spindle machine designed for the production lapping of automobile cylinders.

TANKS AND KETTLES. Stuart & Peterson Co., Burlington, N. J. Catalogue 232, containing data on the line of glass enameled cast-iron kettles, chemical tanks, mixers, etc., made by this company.

PLANER CHUCKS. Skinner Chuck Co., New Britain, Conn. Leaflet illustrating and describing Skinner planer chucks which are made in two styles, with either a round swivel base or a square base.

OIL CIRCUIT BREAKERS. General Electric Co., Schenectady, N. Y. Bulletin 47495.1, describing four improved types of oil circuit breakers for controlling and protecting circuits of large capacity.

HEATERS. Griscom-Russell Co., 90 West St., New York City. Circular describing the G-R instantaneous heater for supplying hot water for boiler feed, heating systems, industrial processes, etc.

WRENCHES. Husky Wrench Co., 928 Sixteenth Ave., Milwaukee, Wis. Circular illustrating and giving price lists of the No. 986 standard interchangeable-socket wrench set, and the various sizes of sockets.

CLEANING MATERIALS. Oakley Chemical Co., 26 Thames St., New York City. Folder descriptive of the service organization maintained by this company for the solution of industrial cleaning problems.

GEARS. Grant Gear Works, cor. Second and B Sts., Boston, Mass. Catalogue and price list for 1925, covering the complete line of gears made by this concern, including iron cut gears, brass cut gears, cast gears, and special gears.

RECORDING AND INDICATING INSTRUMENTS. Uehling Instrument Co., 473 Getty Ave., Paterson, N. J. Bulletins 118 and 118-A descriptive of the "Apex" carbon dioxide recorder and indicating gage, and pneumatic carbon dioxide meter.

THERMALOAD STARTERS AND PRESSURE CONTROL STATIONS. Monitor Controller Co., Baltimore, Md. Circular illustrating an application of Monitor thermaload starters and pressure control stations used to control heating systems.

BALL BEARINGS. New Departure Mfg. Co., Bristol, Conn. Sheets for loose-leaf catalogue containing dimensions and price lists of New Departure single-row and double-row ball bearings, as well as ball bearings of the "Radax" and magneto types.

ELECTRIC MOTORS. Wagner Electric Corporation, St. Louis, Mo. Bulletin 141, illustrating and describing in detail Wagner repulsion-induction motors of the BA type. Bulletin 142, descriptive of Wagner split-phase induction motors of the BB type.

HACKSAW BLADES. Clemson Bros., Inc., Middletown, N. Y., have issued a booklet for the purpose of showing retail hardware dealers how the company is cooperating with them in the sale of Star hacksaws by national advertising and other means, such as signs, display cards, etc.

POWER PRESSES. Niagara Machine & Tool Works, Buffalo, N. Y. Circular illustrating the line of presses made by this company, which includes inclinable presses, straight-sided presses, horn presses, power presses and punches, power squaring shears, power rotary shears, etc.

DIAMOND GAGE. Joyce-Koebel Diamond Co., Inc., 39 W. 32nd St., New York City. Circular giving facts and figures relating to the actual results obtained after three months' use of the "Dykon" diamond gage, which is designed to effect a more economical use of truing diamonds.

INDICATING AND RECORDING INSTRUMENTS. Foxboro Co., Inc., Neponset Ave., Foxboro, Mass. Circular illustrating charts taken from a Foxboro recording thermometer and containing a story of the savings made possible by temperature and pressure records in a specific application.

LATHES. South Bend Lathe Works, 345 E. Madison St., South Bend, Ind., has issued the twenty-fifth revised and enlarged edition of its pamphlet entitled "How to Run a Lathe," containing instructions on the care and operation of a screw-cutting engine lathe, for the machinist apprentice and the amateur mechanic.

BALL BEARINGS. W. A. Jones Foundry & Machine Co., 4409 W. Roosevelt Road, Chicago, Ill. (agent for the Transmission Ball Bearing Co., Inc., 1050 Military Road, Buffalo, N. Y.). Leaflet giving data on the savings effected in thirty representative plants by the use of Chapman ball bearings in place of babbitt bearings.

ELECTRIC DRILLS. Independent Pneumatic Tool Co., 600 W. Jackson Blvd., Chicago, Ill. Catalogues 11 and 14, covering the "Thor" line of pneumatic tools and electric drills. The various tools are illustrated and detailed descriptions, as well as tabulated specifications, are included. The catalogues also illustrate these tools in use on different classes of work.

HEATERS. American Blower Co., Detroit, Mich. Bulletin 1218, descriptive of the American Blower venturafin unit heaters for use in industrial plants. The heaters described have three times the heating capacity of the original unit heater which was placed on the market last year. Leaflet illustrating and describing the American Blower direct-fired heaters, which are adapted for burning any kind of fuel —coal, coke, gas, or wood.

BALL BEARINGS. Bantam Ball Bearing Co., Bantam, Conn. Catalogue 6, covering the complete line of ball thrust bearings made by this company, which includes sizes ranging from ⅜ inch inside diameter to 30 inches outside diameter, for carrying loads from 10 pounds at 500 revolutions per minute to 1,000,000 pounds at 5 revolutions per minute. The catalogue also calls attention to the engineering department which is available for the solution of thrust bearing problems. It is stated in the catalogue that the standard BT type bearing, listed on page 10, is still made in all sizes.